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CONTENTS OF VOLUME XXX, Pt. I

Number		Page
1.	Erosional Modification of Landmarks in Western Kansas During Historic Time. *H. T. U. Smith*	3
2.	Mollusca of the Laverne Formation (Lower Pliocene) of Beaver County, Oklahoma. *A. Byron Leonard* and *Dorothea S. Franzen*	15
3.	A New Genus and Species of Mexican Hylid Frogs. *Edward H. Taylor*	41
4.	Two New Species of Crotalid Snakes from Mexico. *Edward H. Taylor*	47
5.	A New Ambystomid Salamander from the Plateau Region of México. *Edward H. Taylor*	57
6.	The Hylid Genus *Acrodytes*, with Comments on Mexican Forms. *Edward H. Taylor*	63
7.	A New Land Tortoise, *Testudo riggsi*, from the Middle Pliocene of Seward County, Kansas. *Claude W. Hibbard*	71
8.	A New Polycotylid Plesiosaur. *E. S. Riggs*	77
9.	Remains of Birds from the Rexroad Fauna of the Upper Pliocene of Kansas. *Alexander Wetmore*	89
10.	Two New Mammals from the Middle Pliocene of Seward County, Kansas. *Claude W. Hibbard*	107
11.	Present Location of Certain Herpetological and Other Types. *Edward H. Taylor*	117
12.	Genera of Mexican Plethodontid Salamanders, Pt. I. *Edward H. Taylor*	189

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXX, pt. I] MAY 15, 1944 [No. 1

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Erosional Modification of Landmarks in Western Kansas During Historic Time

H. T. U. SMITH,
University of Kansas

ABSTRACT: A study of Castle Rock and Monument Rock, two prominent landmarks in Gove county, Kansas, based on their present condition, and on photographs taken in 1889, 1892 and 1894, demonstrates the amount of erosion during the past fifty years. This gives a measure for estimating total erosion under similar climatic conditions.

INTRODUCTION

TO THE geologist, it is axiomatic that the minor features of a landscape are ephemeral and ever-changing, and to all who have seen the work of rivers in flood the evidence for this is clear. The building and destruction of bars and islands, the undercutting of banks, the widening, deepening, or shifting of channels (cf. Smith, 1940), all these may be effected literally overnight. Although attesting to the efficacy of gradational processes, however, these more striking phenomena do not afford a direct basis for appraising the over-all modification of the land surface, and, indeed, may be misleading. They represent localized and intensified effects along comparatively narrow zones, bordering the stream channels, small in proportion to the total area of the drainage basins. Furthermore, erosion and deposition go hand in hand along rivers; the balance between the two is sometimes difficult to ascertain, and in fact is frequently shifted, even reversed, from time to time. And it may be added that the sedimentary materials directly involved in the work of streams are, to a large extent, undergoing a secondary reworking, having first been prepared and launched on their downward course by other less spectacular but more all-pervasive processes. Thus to

arrive at any adequate concept of the true rate and nature of modification of the landscape in a given region, it is necessary to look to the primary gathering grounds of the detrital materials—to the hills and slopes of the interstream areas, where the effects of erosion, however seemingly imperceptible, may be studied free from the complications of the minor epicycles of degradation and aggradation superimposed on the more steady progress of the erosion cycle proper.

Studies on the actual progress of weathering and slope recession are best made through a comparison of detailed records, such as photos, of the same localities at widely separated points in time. Opportunities for such comparisons come infrequently, and therefore are of particular interest when found, however limited or fragmentary the record. A typical example of such a study has been given by Bryan and La Rue (1927). A similar case, though in a distinctly different climatic and geologic setting, is provided in Gove county, western Kansas, where two prominent landmarks, Castle Rock and Monument Rock, photographed some fifty years ago, are seen to have changed appreciably during the intervening years. A detailed description of these features is given on the following pages, prefaced by a brief résumé of their climatic setting.

CLIMATE

Since climate plays an important part in governing the nature and rate of the erosional attack on rock, the broader significance of any particular example of erosional phenomena can be fully appreciated only in the light of its own climatic environment. The following summary of climatic conditions in Gove county (Flora, 1932) is therefore included in this paper.

The climate prevalent in Gove county may be classed as semiarid. Records at Gove, Ness City, Scott City, and Wakeeney indicate that the average annual rainfall is about 20 inches. In wet years, however, the rainfall ranges up to more than 30 inches, and in dry years it declines to less than 10 inches. The greater part of the rainfall comes during the summer months, reaching a maximum in June or July. January is the month of least precipitation. During the winter, a part of the precipitation occurs as snowfall, which averages close to 20 inches. Generally, however, the ground is not covered for more than a week at a time. Hail storms are common during the summer, and frequently are of sufficient severity to inflict serious damage on crops.

Temperature varies widely through the year. Average monthly temperatures as recorded at Wakeeney range from about 30° in January to about 77° in July. Average monthly maxima, however, range from about 43° to 92° for the same months, and average monthly minima from about 17° to 64°. The highest recorded temperature in the area was 111° at Wakeeney, and the lowest recorded temperature —31° at Healy. Daily temperature ranges are frequently 30°, and not uncommonly 40° to 50°. The average date of the last killing frost in spring is late in April or early in May, and the average date of the first killing frost in fall is in the first half of October.

Detailed data on sunshine and cloudiness are not available for the immediate area concerned, but data from other areas in the same general region suggest that probably about 50 percent of the days of the year are clear, about 30 percent partly cloudy, and 20 percent cloudy.

Detailed figures on relative humidity and rate of evaporation are not available, but it is known that the former is low and the latter very high. At Tribune, some 70 miles farther west, recorded rates of evaporation during the summer range up to more than 16 inches per month.

CASTLE ROCK

Castle Rock is a towerlike mass of Niobrara shale and chalk, about 55 feet in height, located in southeastern Gove county (Fig. 1), in SW ¼ sec. 1, T. 14 S., R. 26 W. It occurs about 1 mile south of Hackberry creek, near the head of a broad, pediment-like slope (cf. Frye and Smith, 1942), rising gently from the inner valley of

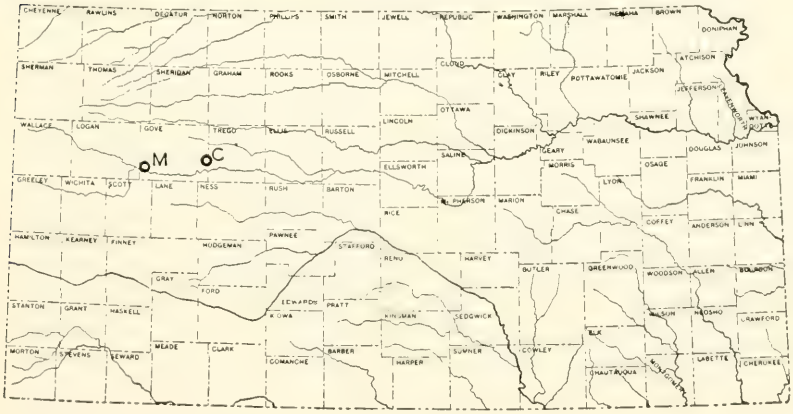

FIG. 1. Location map; *C* represents the location of Castle Rock, and *M* the location of Monument Rock.

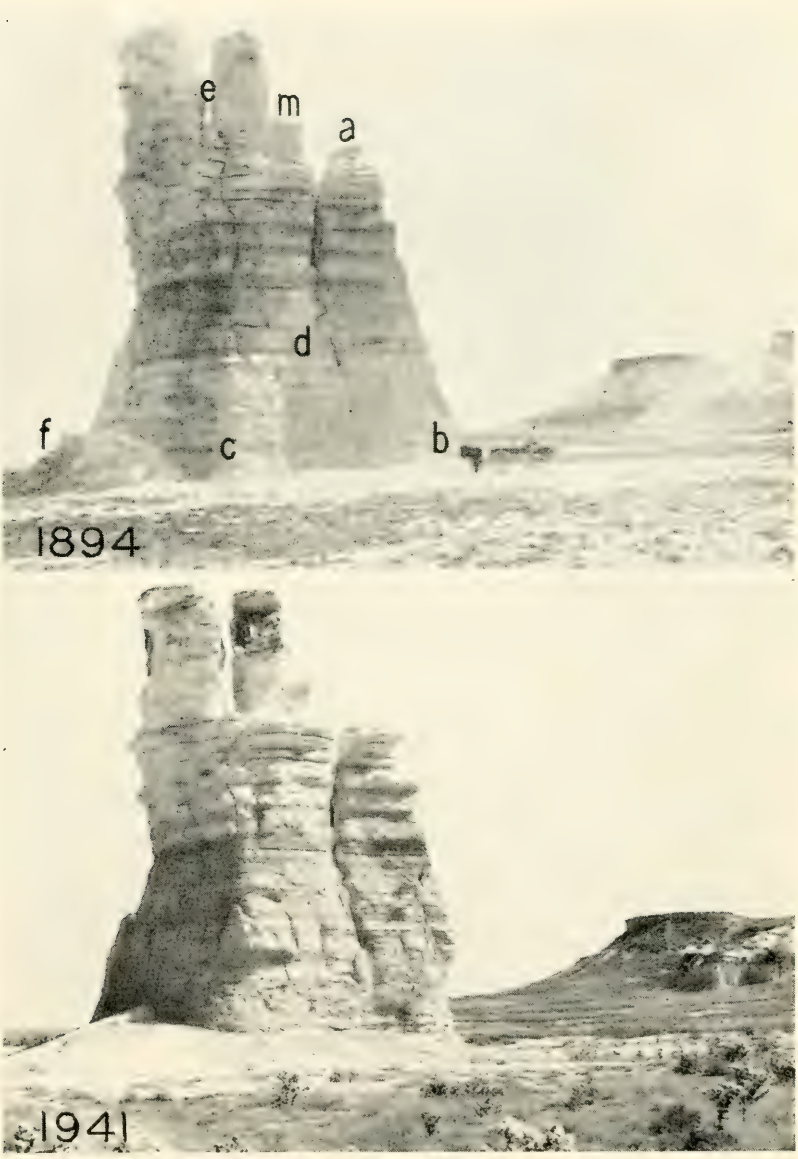

PLATE I. Earlier and later views of Castle Rock, looking southeast. The upper photo is from Williston (1897). Letters indicate points where conspicuous changes may be observed.

the stream to a low upland flat capped by beds of the Ogallala formation. It represents an erosion residual which chanced to be left isolated as the main slope was pushed back toward the divide.

The lower part of Castle Rock is composed of thin-bedded grayish calcareous shale, and the upper part is made of medium to thick bedded, gray to buff chalk. The lower part is cut by innumerable small cracks, joints, and veinlets. It is probable that the general form of the feature is at least partially controlled by more persistent joints.

Williston, in 1897 (p. 240), commented as follows on Castle Rock:

> "Weathering has left the exposed chalk in many places eroded into picturesque objects. The famous Castle Rock, in the valley of the Hackberry about ten miles from its mouth is a lone pyramid several hundred yards from the upland. My first knowledge of the Rock dates from October, 1874, and since that time I have seen but little evidence of erosion. In various places throughout the chalk beds of the Smoky Hill river I have observed marks scratched by myself eighteen years previously that appeared as clear almost as when they were made. The erosion in general is not nearly so rapid as one would think. The smooth, worn surfaces made on the projecting angles of many low cliffs by the buffaloes are still to be seen nearly as smooth as they were twenty years ago."

For purposes of comparing the past and present form of Castle Rock, two photos are available, taken from two different angles. One published by Williston in 1897 (opp. p. 40), and dated 1894, is reproduced here a part of Plate I. Another, shown here in Plate II, was originally published by Hay in 1889 (p. 102), and may be assumed to have been taken at least one year previously. In order to permit detailed comparisons, I rephotographed Castle Rock in 1941 from approximately the same point as those from which the original photos were taken, as nearly as could be determined by inspection. It may be noted, however, that the perspective in my photos is probably not exactly the same as that of the original photos, owing both to differences in the angular field of the cameras used, and to slight differences in camera position and orientation.

On comparing the two sets of photos, certain obvious changes may be observed. The block at *a* has disappeared. The sides have been undercut at *b*, *c*, *g*, and *k*. The crack at *d* and the cleft at *e* have been deepened. The fallen debris at *f* has been reduced. The shoulder at *h* has been lowered, the knob at *i* has been flattened, and the slope at *j* has been worn back. The beds at the horizon of *l* have been more deeply etched. And, finally, the base of the caprock, at

PLATE II. Earlier and later views of Castle Rock, looking north. The upper photo is from Hay (1889). Points which show also in Plate I are indicated by the same letters.

m, has been deeply recessed. Other changes of a minor character could be indicated, but the above suffice to show the general trend.

By superimposing the profiles of Castle Rock as drawn from the earlier and later photos, a rough estimate of the amount of reduction in cross-section area may be obtained. For Plate I, the figure obtained in this way is about 2.5 percent, and for Plate II it is about 6 percent. On the basis of these figures, it would be of interest to attempt an estimate of the total length of time required for the complete reduction of Castle Rock. Direct extrapolation, however, would be erroneous, owing to various complicating factors, of which the following may be mentioned: (1) the rate of reduction is different on different parts of the surface; (2) the rate of reduction is not constant on the same part of the surface—a long period of weathering with little change of form, for example, may pave the way for a sudden slabbing off of large masses of rock with abrupt change in form; (3) a given amount of reduction toward the base affects the reduction of superjacent surface areas by its undermining action, whereas the reduction of the upper slopes has negligible effect on areas beneath; (4) the rate of over-all reduction varies with the ratio of exposed surface area per unit volume of rock, and this ratio may be expected to change as the external form is irregularly modified by erosion. Making due allowance for these factors, however, it may be estimated that a period of time ranging from 500 to 2,000 years will see the total destruction of Castle Rock.

It may be concluded either that Williston underestimated the rate of erosion at Castle Rock, or that the rate has been accelerated since the time of his observations. It should be pointed out, however, that the rock of which Castle Rock is composed is comparatively weak, and that insofar as Williston's other observations refer to more resistant members of the Niobrara formation, there are as yet no grounds for questioning them.

MONUMENT ROCK

The Monument Rocks are a group of castellated erosion residuals located in southwestern Gove county (Fig. 1), along the common boundary line of secs. 33 and 34, T. 14 S., R. 31 W. The southernmost member of this group was photographed by Williston about 1892 (Williston, 1893, opp. p. 108, and 1897, opp. p. 240), and was rephotographed by me in 1941. The two photos are shown together in Plate III. The rock belongs to the Niobrara formation, and is similar to that at Castle Rock, but is less jointed.

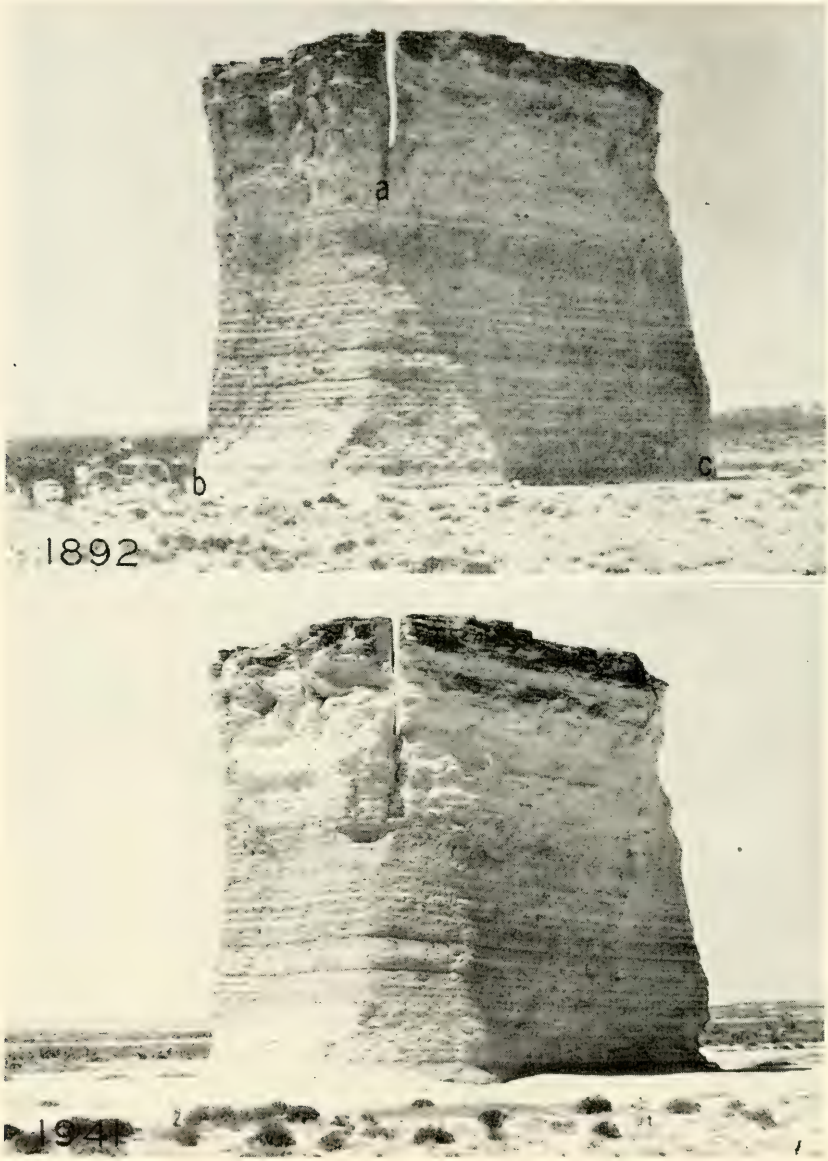

PLATE III. Earlier and later views of Monument Rock, looking west. The upper photo is from Williston (1893 and 1897).

In 1897 (pp. 240-241), Williston wrote as follows concerning Monument Rock:

"One of the most famous landmarks of the Niobrara is the Monument Rocks on the Smoky Hill River. See Plate XXXV. When I first saw them in 1874 the place had been recently abandoned as the stage station of the Overland stage route. A vertical crack in the main rock has deepened very much since that time and it is now but a question of a few years when it will topple over and be demolished."

A comparison of the photos in Plate III indicates that Williston's prediction was rather ill-advised. The only changes to be seen after some fifty years are a slight deepening of the crack at *a* and slight undercutting at *b* and *c*. The reduction of cross-section area has been only about 0.75 per cent. If the cross-section shown in Plate III were representative of the feature as a whole, and erosion were to continue at the same rate as during the past fifty years, a period of from about 3,000 to 7,000 years would be required for the complete reduction of Monument Rock. Actually, however, the cross-section shown is considerably broader than the one at right angles, and it is probable that the length of time estimated above could be considerably reduced.

EROSIONAL PROCESSES

Rock weathering by disintegration is the basic process effecting the reduction of such forms as Castle Rock and the Monument Rocks. Weathering by solution may play a subordinate part. Small particles are loosened by the wedging action effected by hydration of shale lamina and bentonite seams, and perhaps also by the pressure of growing crystals of secondary derivation in minor cracks and crevices. Expansion and contraction produced by wetting and drying and by diurnal temperature changes are probably significant also. It is doubtful, however, whether frost action plays any appreciable part.

The actual dislodgement of particles is probably facilitated by the beating of rain and hail. Occasionally larger masses of rock are brought down by direct falling or toppling after prolonged undermining and weakening by weathering. One example of this may be seen in the upper photo of Plate 1, and others may be observed today around various members of the Monument Rocks. An additional factor difficult to evaluate is the work of man. Since Castle Rock is a favorite picnic spot, it is conceivable that climbing and hacking by visitors may have augmented the normal processes of reduction.

Problematical also is the part which lightning may have played

in cracking or dislodging rocks. Unconfirmed rumor has it that Castle Rock was so affected on at least one occasion. This, indeed, would provide an acceptable explanation for the disappearance for the seemingly fairly stable knob at *a* on Plate I and II. Ample precedent for this supposition is found in the observations of several writers. Hallock, in 1901, described an actual instance of rock thoroughly shattered by a single stroke of lightning, and Barnett, in 1908, gave details on an occurrence of shattered rock best explained as a result of lightning. Andrée (1934) relates that a large stone block was dislodged from a point near the top of one of the pyramids of Egypt by lightning. More recently, Laudermilk and Kennard (1938) found that rocks could be split experimentally by artificial lightning.

Footing the steep sides of Castle Rock and the Monument Rocks are short slopes of moderate declivity resembling miniature pediments (cf. Bradley, 1940). These foot slopes provide a gradient on which the finer weathered material may be carried outward by rain wash and rill work.

CONCLUSIONS

Weathering and erosion of landforms carved in the Niobrara shale and chalk proceeds at a perceptible rate under the semiarid climatic regime of western Kansas. The rate of change varies in detail according to the lithology and structure of the rock. Within a period of a comparatively few thousand years, however, it is probable that many minor features will be obliterated, and the detailed lineaments of the landscape extensively modified. It is evident, nevertheless, that the carving of the broader features of the landscape—the mesas and the sloping plains—is an exceedingly slow process, to be reckoned in terms of hundreds of thousands or millions of years, if the present rate of erosion is representative of longer spans of geologic time. It is possible, however, that the rate was somewhat greater during the more humid conditions which must have accompanied the glacial stages of the Pleistocene period, and that a disproportionate part of the work of erosion took place under those conditions.

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Mollusca of the Laverne Formation (Lower Pliocene) of Beaver County, Oklahoma

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ABSTRACT: The molluscan fauna of the Laverne formation, lower Pliocene, is described. The mollusks as now known comprise 24 species belonging to 15 genera and 10 families. Eleven of the species are described as new: Amnicolidae—*Calipyrgula hibbardi, C. turricula, C. tumida, C. scuta;* Lymnaeidae—*Lymnaea lavernensis;* Planoribidae—*Helisoma valens, H. goodrichi, H. parallelum; Ancylidae—Ferrissia depressus, F. angustus;* Pupillidae—*Gastrocopta anterides.* The literature concerning the formation is reviewed. The geology and the problem of the physical conditions prevailing during the deposition of the fossiliferous strata are discussed.

INTRODUCTION

THE name Laverne formation was first applied to sediments exposed in Harper and Beaver counties, Oklahoma, by V. V. Waite in an unpublished manuscript quoted by Gould and Lonsdale (1926). Chaney and Elias (1936) studied the fossil plants of this formation in Beaver county, and proving to their own satisfaction that they were post-Miocene in age, referred to these beds as lower Pliocene deposits, but did not clarify their relationship to the Ogallala formation. Hesse (Chaney and Elias, 1936, pp. 47-51) reviewed the literature on the Laverne, and after studying the vertebrate fauna, classified these deposits as a zone in the Ogallala formation. Smith (1940) recognized the presence of rocks which unconformably underlie typical Ogallala beds along the Cimarron river valley in Seward county, Kansas. Frye and Hibbard (1941) described these rocks in Meade and Seward counties, Kansas, and correlated them with the Laverne formation of Oklahoma. The Laverne formation was regarded by them as a distinct formation,

rather than a zone of the Ogallala, for the following reasons: "(1) the unconformity that separates the Laverne from the Ogallala is the greatest break in sedimentation recorded in the Pliocene and Pleistocene section in the Meade basin. The beds of the Laverne dip at angles as great as fifteen degrees and are overlain by horizontal beds of the Ogallala; (2) the lithology of the Laverne is distinct from that of the overlying Ogallala—in fact, on a casual inspection these beds more closely resemble the underlying Cretaceous rocks than they do the Ogallala; and (3) it is a unit that is easily recognizable and mappable in the field." Frye and Hibbard, on the strength of these data and on the basis of the vertebrate fossils contained within the sediments, assign the Laverne formation to the lower Pliocene, but suggest the possibility that the lower part of the formation may be upper Miocene in age.

Dr. John C. Frye, Assistant Director, Kansas Geological Survey, comments (personal communication, 1943) upon the geology of the Laverne formation: "The stratigraphy of the Laverne formation has not yet been adequately studied. Available data indicate that, in general, the lower part of the formation is composed dominantly of sandstone and shale, and the upper part consists largely of shale, silt, chalky limestone, and limestone. Most of the beds seem to be discontinuous and cannot be traced over the entire area, although certain types of lithology are characteristic and persistent. Hard, fine-grained limestone is the most resistant rock type and is prominently exposed along canyon sides; chalky limestone is well exposed in a few places and has been quarried locally for building stone; shale is best exposed where it occurs under ledges of dipping limestone; sandstone is best known from test holes; although the coarse-textured, locally derived channel deposits are well exposed at some localities in Beaver county, Oklahoma. The Laverne formation as studied in Kansas and in Beaver county, Oklahoma, consists of 25 to 40 percent sandstone, 30 to 50 percent shale and silt, and 20 to 30 percent limestone and chalky limestone. The total thickness of the formation probably exceeds 150 feet."

During the summers of 1941 and 1942, the senior author was afforded an opportunity of making a collection of mollusks from exposures of the Laverne formation near Gate, Beaver county, Oklahoma. Not more than a total of a day's time was available for study in the field, but three localities were selected for further study, and from each of them several large grain sacks of the matrix containing molluscan remains were taken. These three collecting

stations, from which were recovered the shells which form the basis of this report, are located south and southwest of Gate, Oklahoma.

Locality 2. Five and a half miles south of Gate, in S. 32, T. 4N, R. 28E, where the Laverne is exposed in a road cut. The beds, which dip strongly at this place, consist largely of grayish-green shale and sandy silt, interbedded with thin strata containing carbonized material and fossilized wood.

Locality 3. Six and a half miles south, one half mile west of Gate, in S. 5, T. 3N, R. 28E. This exposure, along the sides of a dry gulch, consists of reddish-gray, slightly sandy, fine silt overlain with cherty limestone.

Locality 4. Six and a half miles south, two and one-half miles west of Gate, in S. 1, T. 3N, R. 27E, where bluish-gray shale is exposed on the sides of an eroded canyon.

Although at present further field studies are impossible, it seems expedient to make the results of our preliminary study of the Laverne molluscan fauna available to those who may find them of value in stratigraphic and faunal studies in southwestern Kansas, western Oklahoma, and surrounding areas. This molluscan fauna is totally unlike any previous reported from the High Plains Tertiary deposits.

ACKNOWLEDGMENTS

We wish to express our appreciation to Doctor H. H. Lane, Director, and to Doctor C. W. Hibbard, Curator, of the Museum of Vertebrate Paleontology, Kansas University Museum of Natural History, who generously supplied facilities for collecting and studying the molluscan fauna herein reported; to Mr. Calvin Goodrich, Doctor Henry van der Schalie and Doctor Elmer G. Berry, Museum of Zoölogy, the University of Michigan; Mr. Henry A. Pilsbry, the Philadelphia Academy of Natural Sciences; Doctor Stanley T. Brooks, Carnegie Museum, Pittsburgh; Doctor William Clench, Museum of Comparative Zoölogy, Harvard; and to Doctor Paul Bartsch, of the National Museum, for their kind assistance with specific systematic problems.

SYSTEMATIC DESCRIPTION

PELECYPODA

UNIONIDAE (d'Orbigny) Ortmann

Unio sp. (?)

The beds in which Waite (Chaney and Elias, op. cit., p. 50) states that . . . "clam shells are found in abundance," have not been found by us, but near locality 3, a few poorly preserved individuals of some species of fresh-water mussel were found in sandy silt below limestone ledges. One of the better of these shells was submitted to Doctor Henry van der Schalie, of the Museum of Zoölogy, University of Michigan, who commented (personal communications, 1943), "The fresh-water specimen is clearly a mussel, but just where it should be placed is very uncertain. There are practically no characters on which to base a diagnosis . . . to judge from its general appearance . . . it is not an *Anodonta* but more closely related to some of the many forms of so-called *Unio* which are known from these fresh-water deposits of the western plains and foot-hills."

SPHAERIIDAE Dall

Musculium Link

Musculium sp.; Plate IV, Fig. 3.

A few fragmentary shells, recognizable as belonging to the genus *Musculium*, but too poorly preserved to allow specific determination, were found associated with *Pisidium*.

Pisidium C. Pfeiffer

Pisidium abditum Haldemann; Plate IV, Fig. 1.

Pisidium noveboracense Prime; Plate IV, Fig. 2.

These two rather well-defined forms of *Pisidium* were submitted to Doctor Stanley T. Brooks of the Carnegie Museum, who identified them, but commented (personal communication, 1943), "Absolute species are a rarity in the Sphaerids. They are ecological groups today; (*Pisidium*) *abditum* is not a species but the name of the pattern of those belonging to one group. . . . So with *noveboracense*." These species of Sphaeriidae are not numerous in the three localities from which our collections were made, but field observations indicate them to be locally abundant.

GASTROPODA

VIVIPARIDAE (Gray) Gill

Viviparus Montfort

Viviparus sp.; Plate A, Fig. 6.

A few broken shells, identified by Mr. Calvin Goodrich of the Museum of Zoölogy, University of Michigan, are *Viviparus;* however, specific characters are lacking.

AMNICOLIDAE (Tryon) Gill

Calipyrgula Pilsbry

Calipyrgula hibbardi sp. nov.; Plate IV, Fig. 7.

Holotype. Number 980, Molluscan Collection, University of Kansas Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. An amnicolid snail of small size, with 7 strongly convex whorls, wound on the elongate spire typical of the genus. *Calipyrgula hibbardi* differs from *C. ellipsostoma Pilsbry,* to which it seems most closely related, by its larger size, more strongly convex whorls, deeply incised suture, conspicuous vertical striations, and more broadly oval aperture.

Description of holotype. Shell small, subperforate; whorls 7, strongly convex; suture deeply incised; whorls increase gradually in size; shape of shell narrowly conic; apex obtuse; first whorl coiled in single plane; height of spire equal to about one-half of total height of shell; body whorl somewhat inflated; peristome broadly oval; lip thin, simple, and continuous, reflected on parietal wall and over umbilical chink; aperture height equal to one-fourth total height of shell; nuclear whorl smooth; remaining whorls embellished with fine, closely spaced, raised lines; spiral lines below periphery fine, scarcely visible even with magnification.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (980)	4.1 mm	1.6 mm.	1.0 mm.	0.6 mm.	7
Paratype (981)	4.2	1.6	1.3	0.8	7
	3.9	1.4	1.2	0.7	6½
	3.2	1.4	1.1	0.8	6

Paratype series, MZUM 162683.[1]

1. All numbers prefixed by MZUM indicate paratype series deposited in the Museum of Zoölogy, the University of Michigan.

Calipyrgula hibbardi is named in honor of Doctor Claude W. Hibbard, Curator of Vertebrate Paleontology, University of Kansas.

Calipyrgula turricula sp. nov.; Plate IV, Fig. 4.

Holotype. Number 982, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 2, five and one-half miles south of Gate, Beaver county, Oklahoma.

Diagnosis. A species with elongate conic shell, small, but among the larger known species of the genus. *Calipyrgula turricula* may be differentiated from *C. hibbardi* by its larger size, larger number of whorls (8), and by its relatively coarse vertical striations.

Description of holotype. Shell small, subperforate, turreted; whorls, 8; apex somewhat obtuse; nuclear whorl slightly projecting; remaining whorls strongly and evenly convex, increasing regularly in size; suture deeply impressed; spire equals scarcely one-half the total height; peristome oval; lip thin, sharp, and continuous, scarcely reflected over the small umbilical chink; aperture slightly less than a third of total height; nuclear whorl unmarked, or but slightly granular; remaining whorls embellished with transverse striations which become coarser as the whorls increase in size, while upon the penultimate and body whorls the striations are fused into irregular corrugations; faint spiral lines present below periphery on body and penultimate whorls; columella a simple spiral column.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (982)	6.6 mm.	2.2 mm.	2.1 mm.	1.1 mm.	8
Paratype (983)	6.5	2.5	2.0	1.4	7
	5.3	2.0	1.6	1.3	7
	4.8	1.8	1.3	1.2	7

Paratype series MZUM 162684.

Spiral lines, scarcely apparent on the shell selected as the type, are lacking on many of our paratypes, and when present, are invariably inconspicuous. The transverse, raised striations vary from numerous fine lines to coarse corrugations, both among individual shells, and upon different parts of the same shell.

Calipyrgula tumida sp. nov.; Plate IV, Fig. 9.

Holotype. Number 984, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 2, five and one-half miles south of Gate, Beaver county, Oklahoma.

Diagnosis. Similar to *Calipyrgula turricula,* but differentiated from it by the obesity of the body whorl, and more broadly conic profile, and by the relatively larger and more elongate aperture.

Description of holotype. Shell small, subperforate, whorls 6½, strongly convex; suture deeply impressed; whorls increase rapidly giving shell a conic shape; apex obtuse; first one and a half whorls coiled in same plane; nucleus projecting slightly; spire occupying about two-fifths of total height; body whorls strongly inflated; diameter approximately one-half total height, peristome oval; lip thin, sharp, continuous, scarcely reflected over the small umbilical chink; aperature height equal to about two-fifths of total height; nuclear whorl smooth; remaining whorls marked with fine, closely spaced transverse striations, which on the body whorl are fused to form faint, irregular ridges; spiral lines poorly developed; columella a simple spiral column.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (984)	5.6 mm.	2.7 mm.	2.1 mm.	1.5 mm.	6½
Paratype (985)	5.0	2.6	1.8	1.6	6
	4.5	2.3	1.7	1.2	6
	4.1	2.2	1.7	1.1	6

Paratype series MZUM 162685.

Although the relative obesity of the body whorl is a constant feature of this species, there is a greater range of size than is found among other known species of the genus. Vertical striations vary from closely spaced, fine, raised lines to aggregations which form low ridges, especially on the lower whorls. Spiral lines are invariably inconspicuous and frequently wanting.

Calipyrgula senta sp. nov.; Plate IV, Fig. 8.

Holotype. Number 986, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south and one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. In general form, *Calipygula senta* is intermediate between the narrow, elongate *C. turricula* and the more broadly conic *C. tumida.* A series of spinous excrescences of variable number, set on a spiral ridge on the periphery, and which may occur on any whorl save the nucleus, and often paralleled below by a low angulate spiral ridge serves to distinguish *C. senta* from both *C. turricula* and *C. tumida,* as well as from other known species of the genus.

Description of holotype. Shell small, subperforate, turreted;

whorls, 7; strongly convex, increasing regularly in size; suture deeply incised; spire occupying two-thirds of total height; diameter of the scarcely inflated body whorl equal to about two-fifths of the total height; peristome oval; lip thin, sharp, continuous, reflected over small umbilical chink; nuclear whorl smooth; remaining whorls marked with fine, closely spaced transverse striations which become heavier on the body whorl; penultimate and body whorls conspicuously embellished with widely spaced, heavy conical spines, united at their bases by a spiral ridge; spines of body whorl paralleled below by a low, angulate ridge; columella a simple spiral column.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (986)	4.8 mm.	2.2 mm.	1.5 mm.	1.2 mm.	7
Paratype (987)	4.7	2.3	1.6	1.2	6½
	4.7	2.2	1.6	1.1	6½
	4.7	2.2	1.6	1.1	6

Paratype series MZUM 162686.

Mature specimens of *Calipyrgula senta* vary little in contour or dimensions, but the number and distribution of the spinelike excrescences is subject to considerable variation; the spines may appear on all whorls save the nuclear whorls, or they may be limited to the body whorl. On occasional examples the spines are obsolete or completely wanting, although in the latter case, the spiral ridge remains as a constant feature. The larger spines are hollow. The angulation below the periphery in some specimens is well defined, in others not well defined, or entirely absent. The angulation varies from a regular to a wrinkled, contorted ridge.

LYMNAEIDAE Broderip

Lymnaea Lamarck

Lymnaea lavernensis sp. nov.; Plate IV, Fig. 11.

Holotype. Number 988, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 4, six and one-half miles south, two and one-half miles west of Gate, Beaver county, Oklahoma.

Diagnosis. A large, bulimiform species, with short spire and inflated body whorl. The surface is typically embellished with strong vertical raised lines, and often with spiral ridges as well, producing an effect of malleation. *Lymnaea lavernensis* somewhat resembles *L. magister* (Baker) in size and general shape, but differs from that species in the greater proportionate size and degree of inflation of the body whorl, and in the relatively larger aperture.

Description of holotype. Shell large, ovate, inflated, bulimiform, almost imperforate; apex acute, whorls of the spire moderately convex; body whorl large, inflated, occupying about two-thirds of total height; suture shallow, incised; the one and one-half nuclear whorls elevated, uniformly and finely granular; remaining surface vertically striate; striae fine and numerous on upper whorls of spire, becoming coarser toward the body whorl upon which they form corrugations; rather coarse, parallel spiral ridges crossing the vertical striations produce an effect of malleation upon the fifth and sixth, and first half of body whorl. Aperture elongate oval, height exceeding half the total height of shell; aperture about half as wide as high; peristome thin, simple, continuous; broadly reflected over the umbilical chink.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (988)	34.6 mm.	19.8 mm.	18.5 mm.	9.6 mm.	7
Paratype (989)	39.7	22.5	24.8	11.9	7
	31.6	18.9	17.2	10.0	6
	28.1	15.8	16.6	8.6	6½
	21.4	12.6	12.6	6.0	6

Paratype series MZUM 162687.

This large *Lymnaea,* named from the Laverne formation, forms a characteristic and conspicuous feature of the fossil remains contained in these deposits. The species is found in deposits of silt, limestone, and shale, and so far as now known, ranges throughout a great part of the total beds of the formation. The bearing this fact may have on the ecological tolerance of this species has not been adequately studied.

So far as known, *Lymnaea magister* (Baker), which appears somewhat closely related to *L. lavernensis,* is restricted in its distribution to Tule Lake, Modoc county, California (Baker, 1934). The geographical remoteness, as well as the separation in time, makes it difficult to determine whether the similarities in the appearance of *L. lavernensis* and *L. magister* are genetic or fortuitous.

The apparent wide extremes in size among examples of *Lymnaea lavernensis* are due largely to differences in degree of maturity. The surface sculpture of the shells of this species consists of vertical striations composed of fine, closely spaced, raised lines, or of more widely spaced, heavier ridges which give the surface a ribbed appearance. An effect of malleation is produced on some shells by heavy spiral ridges which intersect those extending vertically. The whorls of the spire are usually of no more than moderate convexity and separated by a shallow suture, but in certain examples, the suture is more deeply impressed, and the whorls strongly shouldered.

Pseudosuccinea F. C. Baker

Pseudosuccinea columella (Say); Plate IV, Fig. 12.

A large series of *Pseudosuccinea* from the Laverne formation compares well with typical *P. columella* except for being somewhat smaller. It is not possible to say whether the Laverne *Pseudosuccinea* is a small race of *columella*, or whether the larger specimens have not been recovered because of their fragility. The transverse striations are typically developed, but the heavy, indented spiral lines mentioned by Baker (1911, p. 166), are very faint or entirely absent.

Pseudosuccinea is well represented in a number of localities where the Laverne formation is exposed, and in certain places it is the predominating species.

PLANORBIDAE H. A. Adams

Helisoma Swainson

Helisoma antrosum (Conrad); Plate V, Fig. 23.

This species is found in considerable numbers in various deposits in the Laverne formation. It is by far the most numerous of the planorbid snail remains and in actual numbers is rivaled only by the various species of *Calipyrgula*. In form and sculpture the examples studied are quite typical of the shells of living *Helisoma antrosum*, but average somewhat smaller, the largest individuals attaining a diameter of scarcely 8.0 mm.

Helisoma valens sp. nov.; Plate V, Fig. 24.

Holotype. Number 992, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 4, six and one-half miles south, two and one-half miles west of Gate, Beaver county, Oklahoma.

Diagnosis. A helicoid snail of 4½ whorls, approximating *Helisoma antrosum* (Conrad) in size, but differing from that species in several respects: the spire is less depressed; the whorls are convex, rather than carinate; the umbilicus is deeply and narrowly depressed; the sculpture is less conspicuous and the shell is heavier.

Description of holotype. Shell strong, of moderate size, ultrasinistral, whorls 4½, increasing rapidly in size; spire somewhat depressed; all whorls visible above; nuclear whorl rounded, granular; remaining whorls convex; periphery rounded; umbilical deeply depressed, narrow; nuclear whorl partially concealed; surface sculptured with rather fine, obliquely transverse striations, somewhat

coarser below; aperture subtriangular somewhat expended, its width greater than axial height of shell; peristome simple, thickened; terminations approaching and connected across parietal wall with a heavy callus; two rest periods indicated by heavy scars.

	Greater diameter	Lesser diameter	Axial height	Width of peristome	Height of peristome	No. of whorls
Type (992)	10.0 mm.	7.6 mm.	4.3 mm.	5.3 mm.	3.3 mm.	4½
Paratype (993)	7.3	5.6	3.4	4.3	2.2	4

Helisoma valens is quite unlike any other planorbid from the Laverne formation or from the overlying Pleistocene deposits, and does not appear closely related to *H. trivolvis*, the only representative of the genus living in the region today.

Unlike the other planorbids of the Laverne deposits which are represented by adequate series of specimens, *H. valens* is known only from the type and a single paratype.

Helisoma goodrichi sp. nov.; Plate V, Fig. 22.

Holotype. Number 994, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A small species, bearing the characters of the *Pierosoma* group of *Helisoma*. The 4 whorls are subangulate above, convex below, except the nucleus, which is flattened. There is some resemblance to immature examples of *H. carribaeum* (d'Orbigny).

Holotype. Shell small, ultrasinistral, whorls 4, increasing regularly from the nuclear whorl to the aperture; spire depressed; cavity of the spire broadly open exhibiting the convexity of all whorls; nuclear whorl almost flat; remaining whorls subangulate above, convex below, periphery rounded; umbilical cavity not as deeply depressed as cavity of spire, broadly open exhibiting all whorls except nuclear whorl which is partly concealed; surface sculptured with fine, transverse, closely spaced striations, bent obliquely backward on base and becoming coarser on last half of body whorl; aperture high, lunate; peristome thin, simple, subangulate above, rounded at the periphery and straightened below; terminations reflected on parietal wall, approaching but not continuous.

	Greater diameter	Lesser diameter	Axial height	Number of whorls
Type (994)	4.3 mm.	3.6 mm.	2.0 mm.	4
Paratype (995)	4.5	3.8	2.0	3¾
	4.1	3.5	2.0	3¾
	4.0	3.4	1.9	3½
	3.7	2.8	1.9	3¾

Paratype series MZUM 162688.

This small species of *Helisoma* does not resemble any other planorbid known from the High Plains area. Mr. Calvin Goodrich, who examined a series, (personal communication, 1943) suggested a possible relationship with *H. carribaeum* (d'Orbigny). Even on the assumption that our collection is composed entirely of immature shells, which to us seems unlikely, the relationship to *H. carribaeum* seems obscure. The angular contour of the aperture and the depressed, almost funicular cavity above the spire in *H. goodrichi* add credence to our view.

Helisoma goodrichi occurs in deposits with *H. antrosum* Conrad, to which it does not seem closely related, but in much smaller numbers.

Helisoma goodrichi is named in honor of Mr. Calvin Goodrich of the Museum of Zoölogy, University of Michigan.

Helisoma parallelum sp. nov.; Plate V, Fig. 16.

Holotype. Number 996, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A minute species, similar in certain respects to *Helisoma goodrichi,* but its distinctive surface sculpture of parallel raised lines, the lack of carination of the whorls, and the strong callus which connects the terminations of the peristome across the parietal wall, differentiates *H. parallelum* from *H. goodrichi.*

Description of Holotype. Shell small, ultrasinistral; whorls, 3 (shell apparently immature), tightly coiled, increasing regularly from the nuclear whorl to the aperture; spire depressed, cavity of the spire exhibiting all the volutions; nuclear whorl almost flat; remaining whorls convex, periphery rounded; umbilical cavity not as deeply depressed as cavity of spire, broadly open, exhibiting all the whorls; surface covered with fine, transverse, closely spaced striations, bent obliquely backward on the base, with parallel, raised, spiral lines superimposed upon them; aperture high, rhomboidal, of same width as body whorl; peristome thin, simple, ends approaching and connected across the parietal wall by a conspicuous callus.

	Greater diameter	Lesser diameter	Axial height	Number of whorls
Type (996)	2.1 mm.	1.8 mm.	1.0 mm.	3+
Paratype (997)	2.1	1.6	1.0	3
	1.9	1.5	0.9	2¾
	1.5	1.3	0.8	2½

Helisoma parallelum was recovered from deposits containing *H. antrosum* (Conrad) and *H. goodrichi*. The species is now known only from the type and the three paratypes, all of which are obviously immature.

Gyraulus sp.; Plate IV, Fig. 5.

A broken shell bearing the obvious characters of the genus, but damaged so as to make specific determination impossible, together with a few very immature shells constitute the only evidence of *Gyraulus* thus far discovered in the Laverne deposits.

ANCYLIDAE Menke

Ferrissia Walker

Ferrissia depressus sp. nov.; Plate V, Fig. 19.

Holotype. Number 1005, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A small depressed patelliform, obovate, very thin and fragile shell. Its small size, depressed spire, and fragile shell differentiate *Ferrissia depressus* from other known North American species of the genus.

Description of the Holotype. Shell small, thin, very fragile, patelliform, depressed, obovate, slightly wider anteriorly; lateral margins convex, anterior and posterior margins regularly rounded; anterior slope slightly convex, lateral slopes concave, especially posteriorly, posterior slope concave; nucleus heavy, its outline apparent; apex scarcely elevated, rounded, deflected slightly toward the right, and located about one-third of the length of the shell from the posterior end; apex radially striate, striations almost obsolete on remainder of shell; concentric growth lines very fine; surface of shell glossy.

	Length	Diameter	Height
Type (1005)	2.9 mm.	1.9 mm.	0.7 mm.
Paratype (1006)	2.2	1.5	0.5
	2.2	1.4	0.4

The two paratypes, although immature and somewhat smaller than the type, otherwise bear the characters of the type with little or no variation.

Ferrissia angustus sp. nov.; Plate V, Fig. 20, 21.

Holotype. Number 999, Molluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. A small species with laterally compressed, nearly parallel sides, and relatively high spire. *Ferrissia angustus* is distinguished from *F. depressus* by its narrower outline, parallel rather than convex side, and higher spire. Its small size, narrowness, and relative height differentiate *F. angustus* from other known North American species of the genus.

Description of the holotype. Shell small, thin, fragile, patelliform, elevated, narrow, elongated, wider anteriorly; lateral margins almost parallel, the left nearly straight, the right curving medially posteriorly; anterior margin evenly rounded; posterior margin asymmetrically rounded, deflected toward the left; anterior slope rounded, right slope straight, posterior slope slightly concave, left slope convex anteriorly, slightly concave posteriorly; apex scarcely elevated, rounded, slightly deflected toward the right, and about a third of the length of the shell from the posterior end. Apex radially striate, striations faintly visible over remainder of shell; concentric growth lines very fine, giving the surface a silky texture.

	Length	Diameter	Height
Type (999)	2.9 mm.	1.5 mm.	0.9 mm.
Paratype (1007)	2.9	1.5	1.1
	2.9	1.8	0.9
	2.7	1.5	0.8

The shells of *Ferrissia angustus* vary in several respects. The lateral margins are straight and almost parallel to slightly rounded; the posterior margin is symmetrically or asymmetrically rounded; the radial striations vary from distinct to scarcely visible markings; on some shells the concentric growth lines are very fine and closely spaced while on others they are somewhat heavier. In a few examples the peristome is reënforced within by a parallel callus growth, somewhat removed from the margin.

PHYSIDAE Dall

Physa Haldemann

Physa hawni Lea; Plate IV, Fig. 10.

Our collections contain only a few immature shells identified by Dr. William Clench, Harvard Museum of Comparative Zoölogy.

Zonitidae Pfeiffer

Hawaiia Gude

Hawaiia miniscula (Binney); Plate V, Fig. 15.

Three shells are assigned to this species. The fossils are identical, except for their smaller size, with typical *Hawaiia miniscula* (Binney) which lives in the area today.

Pupillidae Turton

Gastrocopta Wollaston

Gastrocopta anterides sp. nov.; Plate V, Fig. 17.

Holotype. Number 1002, Mulluscan Collection, Kansas University Museum of Natural History.

Horizon and type locality. Laverne formation, lower Pliocene, locality No. 3, six and one-half miles south, one-half mile west of Gate, Beaver county, Oklahoma.

Diagnosis. Gastrocopta anterides is a small, ovate species, the shell composed of 5 moderately convex whorls. The anguloparietal lamella extends from the outer margin of the peristome to the throat of the aperture where it ends in a pyramidal buttress. The columellar lamella is horizontally compressed, and turned down within; the basal is missing or at most weakly developed; lower palatal and upper palatal folds set on a callus not deeply immersed. This combination of characters distinguishes *G. anterides* from other known species of the genus and leaves its relationships enigmatical.

Description of holotype. Shell small, perforate, conic-ovate in form; whorls 5, moderately convex, increasing regularly in size, except the last which is compressed around the axis; suture sharply incised, but not deep; aperture obliquely oblong; peristome thin, sharp, margins approaching and connected across parietal wall by thin callus; the one and one-half nuclear whorls nonstriated, granular; remaining whorls marked with fine, closely spaced, oblique striations; denticles 5: the angular projecting as a small spur from the well fused anguloparietal, the tooth extending from the inner margin of the angular lip of the peristome to a point opposite the columellar lamella, terminating in a strong pyramidal buttress; columellar lamella well developed, horizontally compressed around the axis, its inner termination turned downward; basal fold feebly developed; lower palatal dentiform, somewhat laterally compressed, diminishing as it extends inward; upper palatal fold nodose, weakly developed; palatal folds set on a callus which bears faint suggestions

of two interpalatal plicae; the callus appears also as a low external ridge.

	Height	Diameter	Aperture height	Aperture diameter	Number of whorls
Type (1002)	2.9 mm.	1.9 mm.	1.08 mm.	0.99 mm.	5.0

The two paratypes of *Gastrocopta anterides,* except for a few slight variations in the development of the denticles, are identical with the type. The anguloparietal and the columellar lamellae are invariable, but in the one specimen the basal fold is feebly developed, as in the type, in the other nodose. The interpalatal folds are missing in one example, although the callus between the upper and lower palatals is persistent; in this specimen there is an indentation of the angular portion of the peristome suggestive of the angle so characteristic of *Vertigo.*

Gastrocopta riograndensis Sterki; Plate V, Fig. 14.

A small series of shells, although varying in minor details, is referred to *Gastrocopta riograndensis Sterki.* This species has not been found living in the region today and it has not been recovered from local Pleistocene deposits.

Vertigo Drapernaud

Vertigo ovata Say; Plate V, Fig. 13.

These shells, represented in our collections by a small series, compare favorably with typical *Vertigo ovata* Say. This snail is common in local Pleistocene deposits, but the genus is not represented among the living species of this area.

Pupoides Pfeiffer

Pupoides marginatus (Say); Plate V, Fig. 18.

A single specimen which compares favorably with the forms recovered from near-by Pleistocene deposits constitutes the only record of this species from the Laverne formation.

The type of gastropod life one should find associated with flood plain forest as postulated by Chaney and Elias (op. cit. pp. 25-34) is not in evidence from the collections thus far made. These five species mentioned above, none of which are found in an aquatic environment, constitute the only indication of a terrestrial gastropod fauna. All are represented by a small series and all are small enough to float long distances; that is to say, their presence does not necessarily point to near-by shores.

DISCUSSION

A conspicuous feature of the Laverne formation is a zone of diatomaceous marl which has been studied in Seward county, Kansas, by Frye and Hibbard (1941, pp. 402-403) and in Beaver county, Oklahoma, by Chaney and Elias (op. cit., pp. 14-15). Thirty-seven species and varieties of diatoms are known from the Beaver county deposits, of which 12 percent occur among the 34 species and varieties known from the Seward county marls. According to Doctor K. E. Lohman (Frye and Hibbard, op. cit., p. 403) the diatom flora of Seward county ". . . contains a large number of species that live in saline waters at the present time and their occurrence in the beds in Seward county suggests very strongly that they were deposited under similar conditions." Below the diatomaceous marl an ostracod species, *Cyprideis littoralis* (Brady), is present in large numbers. Doctor Willis L. Tressler, of the University of Maryland, who identified the ostracod shields, commented (Frye and Hibbard, op. cit., p. 401): "This form is a species which occurs at the present time in brackish lakes, particularly along the margins." Thus it seems well established that the sediments comprising the diatomaceous marls were deposited under brackish water conditions.

In spite of the present inadequate knowledge of the stratigraphy of the Laverne formation, it seems fairly certain that the fossiliferous zones from which our molluscan collections were made, occur above the diatomaceous marl. Following the same line of thought as that applied to the diatoms and ostracods, and applying it to an interpretation of the molluscan fauna, it seems apparent that ecological conditions in the ancient Laverne basin underwent a change following the deposition of the diatomaceous marl, and that the mollusks lived, not under brackish, but under fresh-water conditions.

The four molluscan species which are present in greatest numbers in the Laverne sediments are *Helisoma antrosum* (Conrad), *Calipyrgula turricula*, *Pseudosuccinea columella* (Say), and *Lymnaea lavernensis*. The success of the species apparently indicates fresh-water streams or freshwater ponds. According to Baker (1928, p. 319) *Helisoma antrosum* is ". . . primarily a river and creek species, not living in the large lakes. . . . In the Wisconsin river it lives along shore and shallow water on debris of various kinds." Although the genus *Calipyrgula* Pilsbry has no known living species, it seems probable that its Laverne representatives lived in quiet, fresh water. Pilsbry (1934, p. 542), in attempting to reconstruct the conditions under which the Kettleman Hills fauna lived, says,

"The great number of shells of some Amnicolidae indicate an abundant aquatic flora, as these snails are most copiously developed when there are masses of filamentous algae and leafy water plants on the bottom. Such growths do not occur in deep water." The same argument seems applicable to the great numbers of *Calipyrgula* in the Laverne, which indicates that they probably lived in shallow, ponded, waters. This argument is substantiated by the presence in the deposits of zygote capsules of some species of *Chara,* as yet not identified. *Pseudosuccinea columella* (Say) "Is an inhabitant of ponds and streams where the water is more or less stagnant; a locality with an abundance of lily pads is particularly favorable; it is found also along the shores in shallow water in the vicinity of cat-tails (*Typha*) and other reeds. . . . Rarely found in running water" (Baker, op. cit. p. 276). *Lymnaea lavernensis,* so far as known an extinct species, is found throughout a wide vertical range in the Laverne sediments above the marl, which may indicate extreme ecological tolerance, but the known facts about the large living species of *Lymnaea* indicate that this species was probably an inhabitant of freshwater streams or ponds.

The remaining aquatic molluscan species, none of which are well represented numerically in the deposits, were likewise inhabitants of freshwater streams or ponds, and without an especial tolerance for brackish-water conditions, if one may judge from the behavior of their living representatives or relatives.

Associated with molluscan fauna were found fish scales, fish vertebrae, and other small bones, identified by Doctor Claude W. Hibbard, Curator of the Museum of Paleontology, University of Kansas, as the remains of gar, other teleost fish, and amphibians, respectively. Even though this fragmentary material does not permit specific identification, it does serve as additional evidence toward the building up of a picture of freshwater conditions during the time the Laverne malluscan fauna was living. The beavers are indicative of the presence of permanent streams, although not confined to them, as pointed out by Hesse (Chaney and Elias, op. cit., p. 70). Chaney and Elias (idem., p. 16) also report among the Laverne flora, the cat-tail, (*Typha*) which is not known to live in brackish water.

These authors, with regard to physical conditions indicated by the Beaver county fossil flora, suggest that the trees constituted a flood plain forest (idem. pp. 25-34) similar to that which exists along the streams in eastern Oklahoma today; in fact they conclude from their observations that the minimum annual rainfall was in excess

of 30 inches. According to their interpretation of the flora, the absence of evergreen oaks indicates that the rainfall was concentrated during the warmer months as is the case in Oklahoma at the present time. The average temperature was considered by them to have been somewhat higher than it is in western Oklahoma today.

On the other hand, the presence of spines on the shell of *Calipyrgula senta* may indicate brackish water conditions in the Laverne after the deposition of the marl, at least locally. It has been shown by Boycott (1929) that *Hyrobia jenkensi* Smith when living in fresh water is devoid of spines, but when this snail is placed in brackish water, its offspring develop spiney excresences. Doctor Henry van der Schalie, Assistant Curator, Division of Mollusca, Museum of Zoölogy, University of Michigan (personal communication, 1943) observed in Puerto Rico that *Potamopyrgus coronatus* Pfeiffer, which is embellished with a series of compressed spines, often inhabits brackish water. Aguayo (1938) mentions *Potamopyrgus* as an inhabitant of brackish estuaries in Cuba, although he does not comment on the spines in relation to habitat. From available data it seems that there may be a correlation between brackish-water environments and the appearance of spines on the shells of snails. The data indicating fresh-water conditions and those which indicate the possibility of brackish-water environments need not necessarily be viewed as mutually contradictory. It was the opinion of Waite (Chaney and Elias, op. cit. p. 50) ". . . that the formation represents a series of small lakes, perhaps similar to the present lakes in northern Indiana. This suggestion is tentatively made for the reason that the formation is scattered and has a variation in lithologic character even though the outcrops are only a short distance apart. The fauna, too, indicates small separate bodies of water. For instance, at one locality, clam shells are found in abundance and not in others. In one locality, fossils were much larger than in others. At another place, a great number of leaves were found. A two-inch seam of peat was found at still another place. These facts would indicate small bodies of water either isolated or connected in which the conditions in one place were different in another and thus the cause for variety of fossils both in size and species."

Chaney and Elias, while not fully in accord with Waite's interpretation, agree that his concept of the physical conditions during the deposition of the Laverne sediments is in the main correct.

A similar concept of conditions prevailing during early Pliocene

times is held by Doctor John C. Frye (personal communication, 1943), who accounts for the presence of saline water by an interesting hypothesis:

"Deposits constituting the Laverne formation were deposited in channels, on flood plains, and in discontinuous or partly connected lakes. . . . The lithology of the chalky limestone and the contained diatoms and ostracodes (Frye and Hibbard, op. cit., pp. 401-403) indicate that the lakes in which these deposits accumulated contained brackish water. This seems to imply a semiarid to arid climate for this region during early Pliocene time. It is possible, however, that the brackish water condition in these lakes was caused by upward migration of brines from the Permian salt beds underlying the area. This hypothesis is given some credence by the fact that throughout most of this area the Laverne strata are folded, and dips of as much as 15 degrees have been measured. If this folding was in part due to solutional phenomena or if the lakes in which these sediments were trapped were formed by deep-seated solution of a type similar to that which occurred during the Pleistocene, (John C. Frye and Stuart L. Schoff, 1942, pp. 35-39) it is quite possible that some brine might have migrated upward and contaminated fresh-water lakes. The thick section of sandstone seems to imply that a relatively large volume of water moved across this area, which could hardly be possible if the climate were arid enough to cause brackish-water conditions in lakes."

In the light of these data and concepts, it is our opinion that conditions during the deposition of the Laverne sediments were characterized by a large shallow lake, or more probably, a series of small lakes or ponds in a large basinal area and fed by fresh-water streams. It seems obvious to us that these lakes or ponds became less saline following the period of the diatomaceous limestone. This change can be accounted for either by an increase in humidity or by assuming stoppage of the fissures through which saline waters may have risen from below, if one accepts Frye's hypothesis. As a matter of fact, there is little lithological evidence which would support an hypothesis of increased humidity following the period of the deposition of the diatomaceous marl.

The problems of the physical conditions during the deposition of the Laverne molluscan fauna are still largely unsolved, and must await an opportunity for intensive studies in this area.

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PLATE IV

FIG. 1. *Pisidium noveboracense* Prime
Catalogue number 978

FIG. 2. *Pisidium abditum* Haldemann
Catalogue number 977

FIG. 3. *Musculium* sp.
Catalogue number 976

FIG. 4. *Calipyrgula turricula* sp. nov.
Holotype
Catalogue number 982

FIG. 5. *Gyraulus* sp.
Catalogue number 998

FIG. 6. *Viviparus* sp.
Catalogue number 979

FIG. 7. *Calipyrgula hibbardi*
Holotype
Catalogue number 980

FIG. 8. *Calipyrgula senta* sp. nov.
Holotype
Catalogue number 986

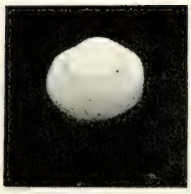
FIG. 9. *Calipyrgula tumida*
Holotype
Catalogue number 984

FIG. 10. *Physa hawni* Lea
Catalogue number 1000

FIG. 11. *Lymnaea lavernensis* sp. nov.
Holotype
Catalogue number 988

FIG. 12. *Pseudosuccinea columella* (Say)
Catalogue number 990

PLATE IV



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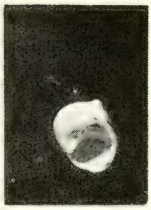

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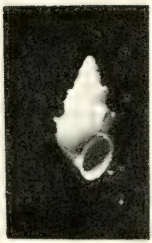

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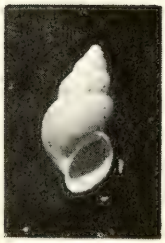

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PLATE V

FIG. 13. *Vertigo ovata* Say
Catalogue number 1004
FIG. 14. *Gastrocopta riograndensis* Sterki
Catalogue number 1003
FIG. 15. *Hawaiia miniscula* (Binney)
Catalogue number 1001
FIG. 16. *Helisoma parallelum* sp. nov.
Holotype
Catalogue number 996
FIG. 17. *Gastrocopta anterides* sp. nov.
Holotype
Catalogue number 1002
FIG. 18. *Pupoides marginatus* (Say)
Catalogue number 1009
FIG. 19. *Ferrissia depressus* sp. nov.
Holotype
Catalogue number 1005
FIG. 20. *Ferrissia angustus* sp. nov.
Holotype
Catalogue number 999
FIG. 21. *Ferrissia angustus* sp. nov.
Holotype
Catalogue number 999
FIG. 22. *Helisoma goodrichi* sp. nov.
Holotype
Catalogue number 994
FIG. 23. *Helisoma antrosum* (Conrad)
Catalogue number 991
FIG. 24. *Helisoma valens* sp. nov.
Holotype
Catalogue number 992

PLATE V

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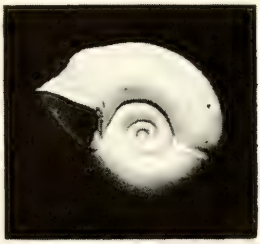
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THE UNIVERSITY OF KANSAS
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A New Genus and Species of Mexican Hylid Frogs

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ABSTRACT: A new genus of hylid frogs, *Ptychohyla,* is described, characterized by a ventrolateral gland of large extent, and a reduced number of nuptial spinules. The genotype, *Ptychohyla adipoventris,* is from Agua del Obispo, Guerrero, México.

A SMALL hylid frog from the lower parts of the Sierra Madre del Sur of Guerrero, México, differs from other known hylids in the presence of a lateroventral gland of large extent. This character, together with that of the nuptial spines, cause me to set it under this new genus herein described.

Genus PTYCHOHYLA novum

Small hylid frogs having a large ventrolateral gland; dorsal skin not obviously glandular. In male, the rugosities of the nuptial callosities (horny spines), which are confined to the first finger, are relatively large, reduced in number and covering a smaller area than in other hylid genera.

Genotype: *Ptychohyla adipoventris* Taylor.

Ptychohyla adipoventris sp. nov.

Hyla erythromma Taylor, Univ. Kansas Sci. Bull., 26, No. 15, 1939 (Nov. 27, 1940), pp. 511, 512 (nec *Hyla erythromma* Taylor 1937).

Type. EHT-HMS No. 21592, collected at Agua del Obispo, Guerrero, México, Aug. 31, 1939, by E. H. Taylor.

Paratypes. EHT-HMS Nos. 21589-21591, 21593-21594, 26834, 28722. Topotypes, same collector; U. S. Nat. Mus. No. 114551, H. M. Smith, Coll.

Diagnosis. A small tree frog, known maximum size, 31.5 mm.,

having a broad, adipose (?) gland extending from near axilla to near groin, and from low on the sides to one-fourth to one-third way across abdomen; vocal sac present in males; 20-50 horny nuptial spines on back and side of first finger, dark brown in color, and not closely spaced; none on other fingers; outer fingers about one-third webbed, toes about four-fifths webbed; distal subarticular tubercle of fourth finger double; tympanum moderately distinct, its diameter about one-half eye diameter; no distinct tarsal fold.

Description of the type. A small frog, the snout very short, high, rather abruptly truncate; nostrils very near anterior point of snout; eye diameter (3.3 mm.) about equal to length of snout (3.55) mm.); diameter of tympanum (1.7 mm.) equal half diameter of eye; width of an eyelid (2.2 mm.) very much narrower than interorbital distance (3.5 mm.); canthus well defined; loreal region concave, the sides of lores nearly vertical, then sloping more obliquely to edge of lip; regions about nostrils swollen prominently, with a depression between; tympanum separated from eye by a distance equal to its own diameter; a straight diagonal fold covers upper part of tympanum.

Tongue flat, thin, somewhat papillate, nearly as broad as long, slightly (1/8) free behind and slightly emarginate; choanae very large; the prevomerine teeth in irregular transverse groups separated from choanae and from each other by nearly equal distances; openings of palatal glands form a transverse groove, the ends of which turn back anterior to choanae, lying much nearer to premaxillaries than to choanae; openings of the eustachian tubes less than half size of choanae.

Terminal digital disks of outer fingers larger than the tympanum; three outer fingers about one-third webbed, the web between first and second less; large median palmar tubercle low, somewhat tripartite; inner tubercle flat, more elongate; subarticular tubercles small, that on fourth finger double, on third finger bifid; supernumerary tubercles on hand rather indistinct; a fold or ridge on underside of forearm; about sixty horny tubercles on dorsal and posterior sides of first finger; tibiotarsal articulation to anterior edge of eye or a little beyond; no distinct tarsal fold; dilation of the tips of the toes equal to those of fingers; toes three-fourths to four-fifths webbed, the web reaching only as high as the subarticular tubercle on inner side of second and third toes; a large inner metatarsal tubercle, a small outer tubercle more distal than inner; supernumerary tubercles obsolete.

Skin appearing smooth, but under lens dorsal part of head, back and upper part of sides minutely corrugated; a few indistinct pustules on side; surface of large gland covered with minute tubercles or corrugations; chin and throat smooth; breast less so; an indistinct and incomplete breast fold; median and posterior part of abdomen granular; most of ventral surface of femur granular; anal flap broad, followed by a deep vertical groove, the sides of which are glandular.

Measurements in mm. Snout to vent, 30; width of head, 11; length of head, 10.2; arm, 18; leg, 47; tibia, 15.5; foot, 20.

Color. In life, dark green or greenish-olive, almost uniform in color on the head, back and the upper part of the sides; lower part of sides oily yellow, with numerous small brown or greenish-brown spots sometimes forming short vertical bars; on the venter the gland continues a third way across abdomen on each side, but the dark spots are now minute flecks; middle of abdomen yellowish-white; chin and throat, canary yellow; undersides of thighs and tibia, flesh color; underside of tarsus and foot, purplish; underside of arm and inner toes, whitish-yellow; area about arm insertion, yellow white; upper lip with a few irregular yellowish areas; faint traces of darker areas on back and hind leg, when specimen is submerged in water.

Variation. The variation in the size of the gland seems to be an age character; in a young specimen it is wholly lateral, not reaching the ventral surface; in old males it is thickened more and is of greater extent. The gland itself consists of closely packed, bottle-shaped glandules four or five times as long as their transverse diameter; when squeezed, an oily substance is exuded.

Color variation. Of the paratypes, Nos. 12594 and 28722 resemble the type very closely in coloration. The last mentioned is a young female and the area occupied by the gland is less, and nearly half the abdomen is free of the gland and is areolate. In this the yellowish-white areas on the lips are more sharply defined. There is a large light spot beginning below the tympanum and running forward and upward so as to include part of the lower eyelid. This light spot encloses a brown spot. The remainder of lip is more yellow than green and shows three spots on each side. One specimen has the upper lip edge almost uniform yellow. In the groin behind the gland there is often a dark-bordered, whitish spot present. In two specimens, the largest male, No. 21590, and a medium sized female, No. 21591, dark spots were visible through the lighter green color and irregular bars were evident on the legs and arms. Eyes reddish.

(In alcohol the olive and green has become brownish, or, in the case of the lighter green specimens, lavender.)

Remarks. The frogs were calling, but the distinctive character of the calls could not be ascertained due to the noise of water falling into the pool, over which was spread a glossy leafed shrub, near the water, on which the specimens were perched. They were not especially wary and those seen were taken with ease; other calls were heard higher in trees but we were not certain that these were the same.

Dr. H. M. Smith, who was collecting with me, obtained a specimen from a tree only a short distance away, likewise, near the same noisy rivulet.

At first I was inclined to believe, despite certain differences, that the specimens were the males of the form described as *Hyla erythromma*, a species collected at this locality at the same time of year, and likewise having red eyes. The single type was a female and lacked any trace of the remarkable gland. Female specimens of the present species were obtained in 1941, showing them to be unlike the known female of *H. erythromma.*

The spring and rivulet at Agua del Obispo is the type locality for four small hylids, *Centrolenella viridissima, Hyla erythromma, Hyla pinorum* and the present *Ptychohyla adipoventris.* The characters distinguishing these four small species are as follows:

I. Body not bright green in life; ventral skin not transparent.
  A. Eye not red, the tympanum concealed; a sharp, distinct tarsal fold extending entire length of tarsus; no yellow color on lip; tibiotarsal articulation to beyond end of snout; legs regularly barred, with narrow, brown, transverse stripes..... *Hyla pinorum* Taylor
  AA. Eye red; tympanum not concealed, none or only a faint trace of a tarsal fold.
    B. Skin shiny smooth, not corrugated; snout rather pointed; heel to anterior edge of eye; a yellow diagonal stripe on top of upper arm; toes three-fifths or less webbed; nostril small; sole of foot nearly smooth, lacking distinct supernumerary tubercles; no ventrolateral gland..... *Hyla erythromma* Taylor
    BB. Skin distinctly corrugated; snout rather sharply truncate with swollen area about nostril and depression between; nostril large; terminal pads on digits larger than preceding form; on sole of foot very numerous distinct tubercles and granulations; heel to between eye and nostril; no stripe on arm. A ventrolateral gland..... *Ptychohyla adipoventris* sp. nov.
II. Dorsal part of body bright green in life, skin transparent on venter..... *Centrolenella viridissima* Taylor

Hyla euthysanota Kellogg, a small frog from El Salvador, differing in having a dermal fringe on arm, foot and tarsus, and above vent, may be congeneric.

While no mention is made of the gland, there is a greatly reduced number of horny, nuptial spines (25) which suggests the

condition obtaining in male *Ptychohyla adipoventris* (25-55 in number). The specimens of *Hyla euthysanota* should be reëxamined to see if a trace of such a gland can be found.

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VOL. XXX, pt. I] MAY 15, 1944 [No. 4

Two New Species of Crotalid Snakes from Mexico

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ABSTRACT: Two new rattlesnakes from México are described: *Crotalus semicornutus* from Mojárachic, Chihuahua, related to the *lepidus* group, and *Crotalus transversus* from the Ajusco Mountains, near Tres Cumbres, Morelos (elevation about 10,000 ft.). The latter species may belong in the *triseriatus* group as defined by Gloyd.

TWO species of the genus *Crotalus*, one from the high plateau region of southern México, the other from southwestern Chihuahua, are described as new.

Crotalus transversus sp. nov.

Type. Edward H. Taylor—Hobart M. Smith Coll. No. 30001; collected about 55 km. SW México (city), near Tres Marias (Tres Cumbres), Morelos, elevation about 10,000 ft., Aug., 1942, by E. Powell.

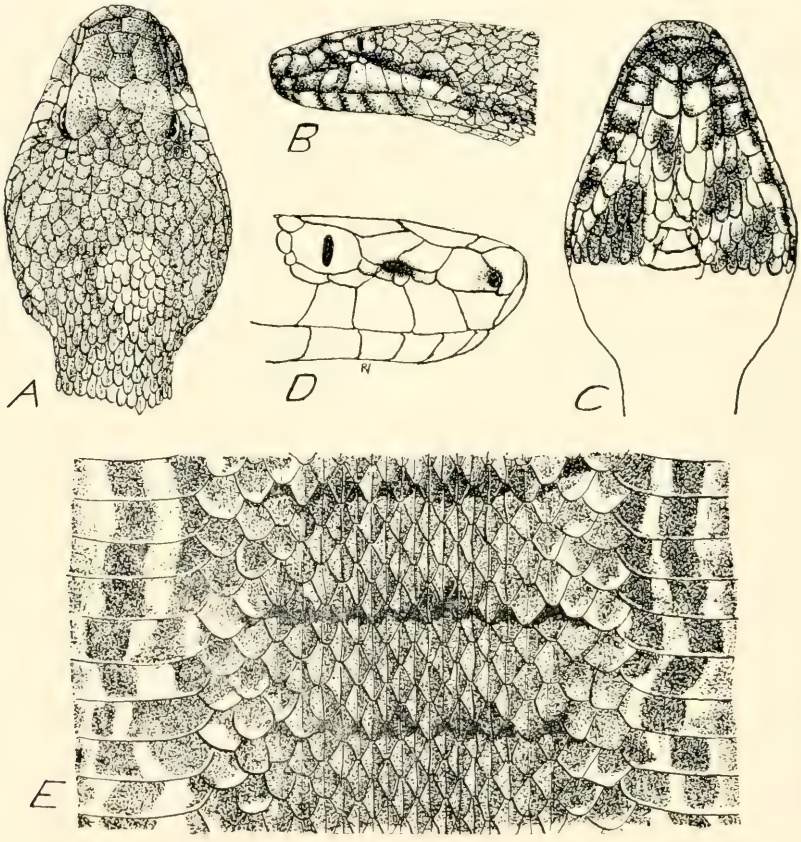
Paratype. EHT-HMS, No. 15879, purchased. México, exact locality uncertain (probably Ajusco range, Morelos).

Diagnosis. A small rattlesnake probably belonging to the *triseriatus* group, but not subspecifically related to any of the known forms. Characterized by 21-19-17 scale rows, upper labials, 8-10, lower labials 9-9. Ventrals, 147; subcaudals, 22-25. Labials separated from the eye by a single row of scales; one scale row only between canthals; upper preocular divided. Brownish with a median light stripe; 34-38 narrow, transverse black stripes on body; 5-7 on tail.*

Description of the type. Head flat, the supraoculars not elevated; rostral visible above, its posterior part rounding; internasals in con-

* There is some difficulty in counting the transverse stripes as many are broken. See figs.

tact, transversely elongate; canthals large, separated from each other by two superimposed intercanthals; a large pair of intersupraoculars, separating the supraoculars anteriorly, three or four small scales separating them posteriorly; occipital scales small, rather irregular. Nasal completely divided, the anterior and posterior parts of nearly equal areas; posterior nasal touching two labials; no loreals; three small scales border lower edge of pit; preoculars divided, the anterior part broadly in contact with posterior nasal, but separated from labial; lower preocular very small; two suboculars, the anterior (lacrymal) scarcely larger than the posterior, both in contact with the labials; three small postoculars. 9 (left), 10 (right), upper labials; 9 lower labials; the 3 anterior touch the enlarged chinshields; first labials in contact medially.



TEXT FIG. 1. *Crotalus transversus* sp. nov. Type. *A*. Dorsal view of head, × 2. *B*. Lateral view of head, × 2. *C*. Ventral view of head, × 2. *D*. Lateral view of head (enlarged). *E*. Dorsal color pattern, enlarged, diagrammatic.

Scale rows, 33 (at 3d ventral), 21, 21, 19, 17; the two outer rows lacking keels; ventrals 147, the first separated from the chinshields by four pairs of small scales; anal single; subcaudals: 1 divided + 12 single + 9 divided = 22; six small rattles.

Color in alcohol. Brownish on sides, the median dorsal region lighter (salmon?); about 45 narrow black, more or less continuous, transverse stripes, on body and tail, which usually reach to the second scale row on the sides of the body; two outer scale rows with numerous small whitish flecks; ventrals with quadrangular dark marks forming irregular lines, the two outer series on each side darker and more distinct than the median. Head dark with an indistinct light stripe across the head at level of the anterior part of supraoculars; lower two-thirds of posterior upper labials whitish; first three labials dark; lower labials and chin spotted with black; the dorsal indefinite light stripe terminates anteriorly just back of occiput in a rounded, darker-edged spot; a black stripe from behind eye to angle of mouth, not bordered above by a light line.

Measurements in mm. Total length, 464; tail, 38; width of head, 19; length of head, 19; length of rattles, 14.

Variation. The paratype is a small specimen from México, and very probably from the Ajusco Mountains between Tres Marias (Tres Cumbres), Morelos, and Cuernavaca. The body is grayish black, but the indefinite dorsal light stripe which terminates in a definite light spot on occiput is present; the body and tail are traversed by 39 narrow dark stripes a little more than two scales wide; a darp spot is present at each end of the stripe, which may touch the stripe, and there is also an indefinite series of small dark spots low on sides, between these latter; the pigment below is largely on the outer sides of the ventrals; the chin is spotted as in the type.

PLATE VI

FIG. A. *Crotalus transversus* sp. nov. Paratype, EHT-HMS No. 15879, México. (Somewhat reduced; actual length, 183 mm.).

FIG. B. *Crotalus transversus* sp. nov. Type, EHT-HMS No. 30001, 55 km. SW México (city) near Tres Cumbres, Morelos. (Somewhat reduced; actual length, 464 mm.).

There is a single elongate scale between the canthals. The internasals are less elongate; there are three anterior intersupraoculars. The labials are 8-8 above, 9-9 below. The scale formula and ventral count are identical with type; caudals: 22 (single) +3 (divided) =25. There is a single row of scales between labials and eye; no loreal, and only two instead of three small scales below the pit, and two instead of three postoculars. The total length of the specimen is 183 mm.

Remarks. That this form is not a subspecies of *Crotalus triseriatus* seems to be proved by the presence of *C. triseriatus anahuacus* in this immediate locality.

It may be distinguished from forms of *triseriatus* by the reduced number of scale rows, 21 as opposed to 23-25; a single row of scales between eyes and labials; reduced labial count and different squamation in loreal region, and the very distinctive marking and coloration.

Mr. Martín del Campo has recently described a small rattlesnake from the "Lagunas de Cempoala" (Zempoala) [Morelos or México] having a reduced squamation (scale formula 21, 19, 17, and 9 upper and lower labials). However, he describes the dorsal markings as "manchas dorsales, 45; caudales, 8." Since he does not describe the very characteristic color pattern of *transversus,* I conclude that he has correctly placed it as a variety of *Crotalus triseriatus anahuacus* Gloyd.

I am indebted to Dr. W. B. Davis, head of the Department of Fish and Game of the Texas Mechanical and Agricultural College, and Mr. Max Whisenhunt of the same institution, for the privilege of describing this striking new species, and for the gift of the type.

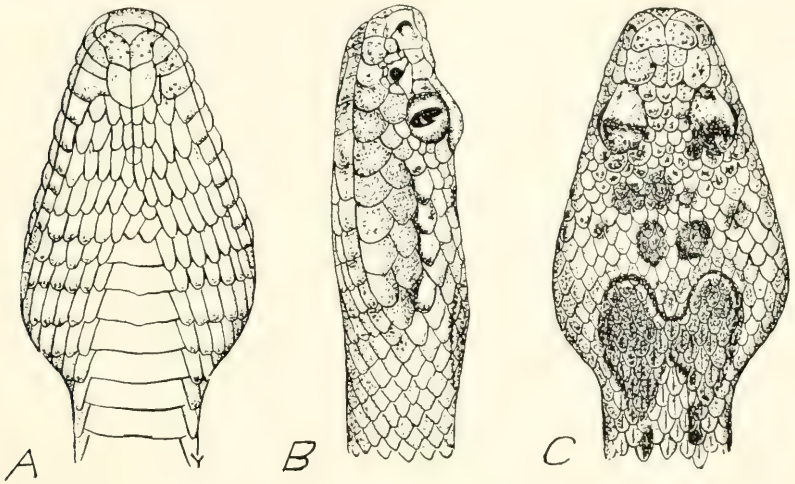
Crotalus semicornutus sp. nov.

Type. EHT-HMS, No. 23014 ♂; collected at Mojárachic, Chihuahua, 1939, by Irving W. Knobloch.

Diagnosis. A small rattlesnake with a single median series of dorsal blotches about five scales wide alternating with less distinct, paired spots; supraocular strongly elevated on its outer edge, much longer than its distance from tip of snout; upper preocular divided, the anterior part bending over edge of canthus, and separated from posterior nasal; a short, dark, light-bordered stripe beginning some distance behind eye and continuing to angle of mouth. One (lacrymal) or two scales between eye and labials; three or four loreals present; a pair of large internasals, in contact; a pair of large can-

thals separated by two pairs of scales; three series of scales between the supraoculars.

Description of the type. Head rather triangular, strongly distinct from neck; snout narrow, rather oval in profile; supraoculars large, strongly elevated on the edge, forming a hornlike ridge; a pair of very large internasals, in contact medially, separated from the supraoculars by large canthal scales, which are themselves separated medially by two pairs of small intercanthals; supraoculars separated



TEXT FIG. 2. *Crotalus semicornutus* sp. nov. Type. *A*. Ventral view of the head, × 2. *B*. Lateral view of head, × 2. *C*. Dorsal view of head, × 2.

by three series of scales anteriorly and by four or five posteriorly; rostral broader than high, the part visible above triangular; nasal scales fused above nostril, sutured below nostril, the anterior part wider and longer than posterior; upper preocular divided, the anterior part largest, turning up over canthus; four loreal scales, the one between the postnasal and the anterior preocular, largest; others small; three scales border the pit, the lower scale separated from the labials by small intercalated scales (left side), or the anterior touching labial (right side); six postocular and subocular scales border posterior and inferior part of eye, the anterior subocular (lacrymal) largest, touching two labials; posterior suboculars separated from labials by one or two scales; 10 (left), or 11 (right) upper labials; mental triangular, its labial border greater than that of rostral; first pair of chinshields bordered by 3 (left) or 4 (right) lower labials; body scales keeled save outer row. Scale formula:

PLATE VII. *Crotalus scmicornutus* sp. nov. Type, EHT-HMS No. 23014, Mojárachic, Chihuahua. (Somewhat enlarged; actual length, 493 mm.)

28, 25, 21, 23, 17, 17; ventrals, 167; 16 undivided subcaudals, followed by 3 divided scales; anal single; 13 scales about base of tail; 10 about middle of tail; six rattles present.

Measurement in mm. Total length, 493; tail 37.5; rattle 21.6; width of head, 17; length of head, 20.3; length of supraocular, 6.

Color. The dorsal ground color is pearl gray with the sides somewhat lavender-gray to pinkish salmon (low on side). On body a median series of about 16 very irregularly-edged dark spots, which alternate with smaller, irregular, more or less elongate paired spots (occasionally fused on posterior part of body or broken in two or three parts); an irregular row of dark flecks on the sixth scale row, each covering area equal to one scale; a similar series on the fourth row; still another row of dark flecks on first, second and third rows, the spots irregular and sometimes including parts of three scales, but usually covering a total area of about two whole scales; a pair of nuchal spots present, which are in contact medially; several small black spots on occiput, the anterior pair touching the supraoculars; an elongate dark stripe beginning behind eye is bordered above and behind by a whitish line; labials pinkish salmon, the upper labials heavily pigmented with ashy gray, the lower labials pigmented on their sutures; posterior half of tail somewhat orange above, yellowish below. Ventral surface dirty whitish with the anterior and posterior part of each ventral grayish or blackish, often covering more than half of the outer part of ventrals. Two black spots on the dorsal part of tail and one chestnut spot; ventral surface of posterior part of tail lacking dark markings.

Remarks. The relationship of the species is believed to be with *Crotalus lepidus.* It differs from that species in having a larger supraocular, much longer than its distance from the end of the snout, and in having the supraocular strongly elevated with a keel-like edge, allowing the upper fourth of the eye to be higher than the interorbital level. The color pattern is very different from that of typical specimens of *C. lepidus klauberi* Gloyd or *C. lepidus lepidus* (Kennicott) and the caudal scales are fewer. There is however a similarity in the general squamation; yellowish orange tail coloration and the presence of the pinkish-salmon coloration low on sides.

The specimen comes from an elevation of about 6,000 feet in the Sierra Madre mountains.

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A New Ambystomid Salamander from the Plateau Region of Mexico

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ABSTRACT: A salamander, *Ambystoma granulosum*, from the high plateau region of western México, México, is described. It is related to *Ambystoma bombypellum* Taylor.

A SPECIES of salamander, together with large numbers of salamander larvae, was obtained in shallow artificial ponds in the high prairie regions of western México (state). The dermal glands give the surface of the adult animal a somewhat granular appearance particularly if the glands are gorged, or the skin is slightly shrunken. There is no absolute proof that the larvae taken are the young of the species, but it is highly probably that they are.

Ambystoma granulosum sp. nov.

Type. EHT-HMS, No. 29805, collected at km. 74, about 12 miles northwest of Toluca, México, México, Sept. 10, 1939, by Edward H. Taylor and Hobart M. Smith.

Paratypes. Adults: EHT-HMS, No. 29804, collected with type; Nos. 24042-24044, at km. 70, northwest of Toluca, Sept., 1940, by Richard Clark Taylor and E. H. Taylor. Larvae: EHT-HMS, Nos. 24045-24250, kms. 70-74, 10-12 miles northwest of Toluca, México; U. S. N. M. Nos. 116630-116653, kms. 70-73, same locality. Taylor and Smith collectors.

Diagnosis. Related to *Ambystoma bombypellum,* but with a shorter, more elevated tail; body distinctly more elevated; limbs proportionally longer, the head shorter and broader. Color greenish or yellowish-olive to brown-olive above with numerous small black

spots. Yellowish or yellowish-brown on sides and venter, without marks. Tail spotted black like the back.

Description of the type. Head moderately high, its greatest width behind jaw angle (23 mm.) greater than measurement from tip of snout to gular fold (20 mm.), but less than distance from tip of snout to the gular groove, dorsally (30.2 mm.); length of eye (3.5 mm.), less than distance to nostril (4.8 mm.); distance between nostrils, 5.9 mm.; distance between orbits, 8 mm.; eyelid width, 1.8 mm.; length of snout, 7.2 mm.

A large, transversely oval, palatal pit; choanae transversely oval, the distance between them 7 mm.; prevomero-palatine teeth on a somewhat arched ridge, extending across palate, with a slight diastema between the prevomerine and palatine series; a slight indication of a mesial break in the dental ridge, but the teeth here are continuous. About 48-48 maxillary-premaxillary teeth, and approximately the same number of mandibular teeth, the latter forming a rather irregular series; about 11-13 prevomerine teeth; 9 palatine teeth.

Tongue rather small with longitudinal lamella (larger tongues in older specimens). The larval skinfold at corner of mouth still evident as a small flap on the upper lip and a small fold on back part of lower lip; no trace of splenial teeth.

Skin above finely corrugated or granular, more especially granular in caudal region; a groove behind eye curving down to near corner of mouth; gular fold prominent; the skin of chin forming longitudinal folds; a deep groove passing from corners of gular fold, halfway to the median dorsal line.

A double series of enlarged pits beginning medial to the nostrils and running back above orbit, then down behind it; another series of pits beginning behind nostril and covering much of the area below eye; another single series on the lower jaw. The dorsolateral, lateral and lateroventral neuromast organs represented by a few scattered pores. Twelve costal grooves, all of which can be traced across abdomen; limbs of moderate length; when adpressed the longest toes reach the wrist; an inner and an outer tubercle on palm and sole. Fingers 1, 4, 2, 3, in order of increasing length; toes 1, 5, 2, 3, 4; the distal part of metacarpals and metatarsals free; an indistinct ridge from outer toe onto tarsus; caudal fin thickened, scarcely distinguishable from remainder of tail; subcaudal fin much reduced and not or but little thickened; tail a little shorter than head and body; median part of tail deeper than base; cloacal walls with folds and with a small projection from the anterior part.

Color. Yellowish-olive above and on sides, darker on dorsum; venter dirty, or yellowish-flesh with a few scattered black spots on dorsum extending onto the sides; tail similarly marked.

Table of measurements (in mm.) of type and paratypes of *Ambystoma granulosum.*

Number	29805	29804	24042	24043	24044
Sex	♂	♀	♀	♂	♂
Snout to back end of vent	92	81	89	92	86
Tail length	77	62	75	74	71
Head, greatest width	23	19	22	21	21
Head, length to gular fold (ventral),	20	20	20.2	20	19.5
Head, length to level of gular groove (dorsal)	30.2	27	28	28.8	26.3
Arm	32	26	29	29	27.5
Leg	34	28	30	32	28
Axilla to groin	45	38	41	45	40
Tail, depth at base	16	14	16	15	14
Tail, greatest depth	18	16	17	16.5	15
Depth of body	24.5	22	23.5	24	25

Description of the larvae. The largest larva, EHT-HMS, No. 24094, measures 90 millimeters snout to vent; the tail, 70. The head is broad (28 mm.); its length to base of gills, 36.5. The longest gills are 25 mm.

The dorsal fin arising at a point about on the level of the gill bases, and in the young, forms a continuous curve to end of tail, the dorsal part being most elevated near base of tail; elevation of subcaudal part of fin usually less than the dorsal, although a few specimens have it about equal to dorsal; when limbs are adpressed, tips of toes reach to elbow; web on the foot a little more extensive than in adult, involving the metatarsals to their tips.

Maxillary-premaxillary teeth in a very uneven row, appearing as if there were more than a single row of teeth; prevomerine teeth on two strongly elevated, widened ridges, about 45 teeth on each, arranged in several series, many teeth directed backwards; the tooth groups, in contact mesially, lie anterior to a line connecting the choanae; the palato-pterygoid series in two longitudinal patches each with about 45 teeth, the teeth arranged in several transverse or diagonal series. About 60 splenial teeth on each side arranged in several short series. Mandibular teeth very irregular. Tongue undeveloped.

The larvae are light flesh color with little or no spotting on the back, or elsewhere. There is some pigment in the tail fin, especially near the tip and on the underside, some specimens having this region nearly black.

The figure (2) shows such a specimen, the ventral fin being less elevated than normal.

Remarks. The oldest adults (those in which the fold had been resorbed on the back part of the lower jaw, and the upper flap much narrowed) were dark dirty olive in color, the dorsal black spots discernible with difficulty. The prevomero-palatine series of teeth tend to straighten out more across the palate, and are less arched.

I have presumed that this species is related to *Ambystoma bombypellum* Taylor, a species known only from two recently transformed adults. These latter are uniform lavender in color, and the habitus is very different. In that form the skin is very smooth and shining. The body is not elevated medially; the tail is as elevated at its base as elsewhere, and the caudal fin is not retained in the adult (see fig. Univ. Kansas Sci. Bull., Vol. 25, 1938 (1939), plate XXIV, p. 303, fig. 1).

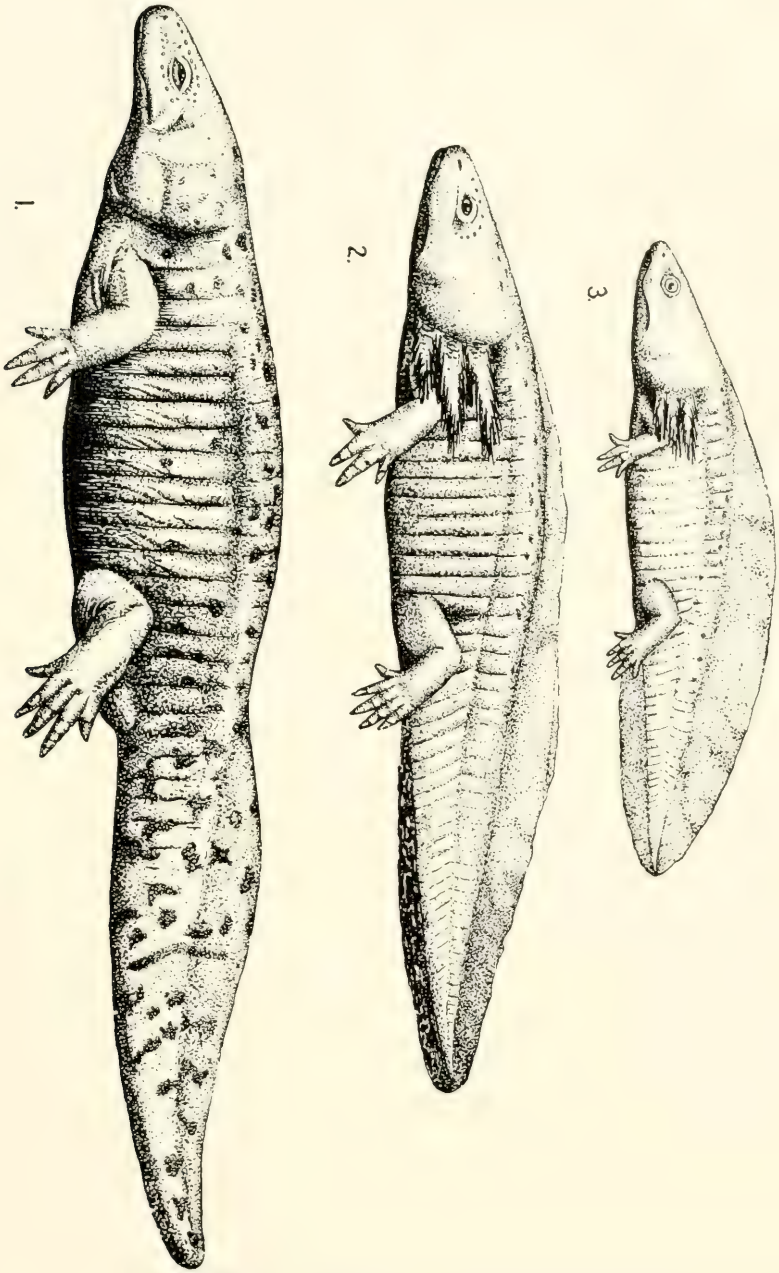

PLATE VIII. *Ambystoma granulosum* sp. nov.

FIG. 1. Type EHT-HMS No. 29805, 12 miles NW Toluca, México, México. About natural size.

FIG. 2. Larva of same, nearly full grown (× 1).

FIG. 3. Larva of same, young (× 1).

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The Hylid Genus *Acrodytes*, with Comments on Mexican Forms

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ABSTRACT: The frog genus *Acrodytes*, Fitzinger (1843) (Hylidae), placed in the synonymy of *Hyla* by Boulenger (1882), is revived. Three Mexican forms are recognized. Of these two are new; one, from southern Guerrero, México, is described as *Acrodytes inflata*, because of a peculiar habit of inflating the body with air when calling. The other new species is being described elsewhere.

The name *Rana venulosa* (Laurenti) is based on a figure of a frog in Seba,* who states that its habitat is in "Indiis." It is doubtful whether it can be identified among the known forms of the genus.

THE Hylid frogs allied to "*Hyla venulosa*" (*auctorum*), having in the males a pair of vocal sacs extruded behind the angles of the jaws, are generically separable from the genus *Hyla* (*sensu lato*). These also have a characteristic pattern for the prevomerine tooth groups; broadened, somewhat spatulate, maxillary teeth with the transverse groove at their terminus giving the tooth in profile a seemingly more strongly bifid appearance than is usual in the *Hylidae*; a "paratoid" gland of considerable area, usually diffuse, on the head and back, giving the skin a thickened appearance, and producing secretions apparently physiologically different from those of other hylid species; palate more completely roofed with bone. Species having these characters, I believe, without question, form a natural generic group.

For this group there have been proposed two names: *Acrodytes* and *Scytopis*. *Acrodytes* Fitzinger, Systema reptilium, fasc. 1, 1843, p. 30, has as a genotype *Hyla venulosa* Daudin = *Rana venulosa*

* Seba, A., Locupletissimi rerum naturalium thesauri accurata descriptio, et iconibus artificiossimis expressio, per universam physices historiam, Amsterdam, vol. 1, p. 120, pl. 76, fig. 1, 1734.

Laurenti 1768, Synopsin reptilium, 1768, p. 31 ("Indiis" *ex errore*)]. *Scytopis* Cope, Proc. Acad. Nat. Sci. Philadelphia, Vol. 14, Sept., 1862, p. 354, has as genotype a Paraguayan species, *Scytopis hebes* Cope (*loc. cit.* pp. 354-355) = *Hyla venulosa* (Laurenti) (*fide* Boulenger)]. Thus the same species apparently serves as genotype for both names, and the oldest, *Acrodytes*, must take precedence over *Scytopis*.

It is of interest that Cope in 1862 used the Fitzinger name, *Acrodytes venulosa*, and later the same year described *Scytopis* for his *Scytopis hebes* which has been referred to the synonymy of *venulosa*. In 1865 (Nat. Hist. Rev., p. 109) Cope recognizes both genera, *Acrodytes* and *Scytopis*, separating them on the basis of the presence of a paratoid in the latter, its absence in the former. Then in 1866 (Journ. Acad. Nat. Sci. Philadelphia, Vol. 6, Art. 2, 1866, p. 85) he refers the species *venulosa* to his *Scytopis*.

There are three forms of the genus known to occur in México. They may be distinguished by the following characters.

A. Adults lacking a dorsal pattern of black blotches (possibly present in very young), occasionally with pustules dark and some ventral stippling; eye larger, greater than its distance from nostril; known maximum size 70 mm., Chiapas.....sp. nov.

AA. Dorsal pattern of stripes or blotches, eye less than or equal to distance from nostril.

B. The anterior dorsal marks separated from the posterior ones by a broad band of ground color; venter immaculate; maximum known size, male, 98 mm., (females much larger?), Guerrero (and ? Colima).....*Acrodytes inflata* sp. nov.

BB. Anterior marks usually two, dim, dark, dorsal stripes, with a light dorsolateral stripe; the anterior and posterior dorsal markings usually continuous; skin thicker on head and back; size, 83 mm., San Luis Potosí, Veracruz and Chiapas.....*Acrodytes spilomma* Cope

Acrodytes inflata sp. nov.

Type. EHT-HMS, No. 17890; collected near La Venta, Guerrero, June 27, 1938, by Edward H. Taylor.

Paratypes. EHT-HMS, Nos. 17889, 17891. Topotypes taken with the types.

Diagnosis. Very large tree frogs related to *Acrodytes spilomma*. Snout to vent, 98 mm. in males (females probably much larger); with large vocal sacs evaginated behind angle of jaws; prevomerine teeth in two broad, slightly curved, transverse series of 10-12 teeth, separated medially by a distance nearly equal to their distance from choanae; tympanum five-eighths of the diameter of eye; diameter of eye nearly equal to its distance from nostril; interorbital width distinctly greater than an eyelid; outer fingers one-third, toes three-fourths to four-fifths webbed; tibiotarsal articulation reaching the eye; no small yellow gland on distal part of posterior face of femur;

black dorsal markings; venter immaculate; paratoid glands present on occiput and back.

Description of the type. The head rather flat, with eyes much elevated; width of head (30 mm.) greater than length (25 mm.); eye large (8 mm.), equal to its distance from nostril; width of an eyelid (6.5 mm.) much less than interorbital distance (9 mm.).

Canthus rostralis lacking, the loreal region not or but slightly concave; snout slopes downward very abruptly from the region of nostrils, which are near the anterior point of snout; tympanum very distinct, a little higher than long, somewhat irregular in shape, its length (5 mm.) equal to five-eighths diameter of eye, and separated from the eye by a distance less than the length of tympanum.

Tongue much broader than long, slightly notched behind, only the posterior edge free; choanae transversely elongated, somewhat angulate on inner edge; prevomerine teeth in two transverse series, lying between the posterior edges of the choanae, and separated from the choanae by a distance equal to (or somewhat greater than) that between the two groups. Openings of the vocal sacs large, directed back; openings of the palatal glands form a sinuous groove, interrupted medially by small separate pores, and nearer to the front of the palate than to the prevomerine teeth.

Outer digits of hand about one third webbed, their edges with narrow skin folds; terminal pads only a little wider than digits; dorsal surface of pads with very pronounced, moundlike elevations; subarticular tubercles relatively small, that on outer toe larger, somewhat bifid; supernumerary tubercles rather indistinct, as are the palmar tubercles; base of first finger covered with an area of horn, granular, rather than spiny; none on second or third fingers.

Feet a little more than three-fourths webbed; toes with the terminal pads a little narrower than those on hand, but these likewise with narrow lateral folds; inner metatarsal tubercle flat, not strongly marked; a small indistinct outer tubercle; subarticular tubercles small; supernumerary tubercles indistinct; tarsal "fold" flat, widened, scarcely discernible.

Skin of head and body smooth; indistinct pustules present on back, more evident on sides; legs and arms nearly smooth; ventral surfaces of chin, breast, venter, and most of the under part of thigh strongly granular or areolate; no small gland present on distal part of the posterior surface of the thigh (present in *spilomma* and certain Central and South American species); a fold above the tympanum which encroaches somewhat on the latter.

Color. Dark reddish-brown above; some black spots on anterior part of the back, more or less connected; a broad transverse band of ground color separates the large indefinite black spot covering posterior part of back from the dark marking on the anterior; a few spots or flecks on the sides; arm and leg with black bars having somewhat lighter, irregular edges; rather large whitish-cream spots about anus; venter uniformly dirty cream; under sides of feet darker than palms.

Measurements in mm. of Nos. 17889, 17890, 17891; sex, ♂, ♂, ♂; snout to vent, 92, 95, 84; width of head, 30.5, 30, 29; length of head, 24.8, 25, 23; arm, 54, 58, 51; leg, 125, 127, 117; tibia, 41, 44, 38.5; foot, 55, 56, 50.

Variation. All three of the specimens have a reddish-brown ground color. The black mark on the back, originating on the eyelids, continues two-thirds of the length of the body, where it is interrupted. It may enclose areas of the ground color. The large spot in the lumbar region, reaching down on sides and extending back to near the anus, likewise may not be of solid color. The light areas near the anus and on femur may have some small blackish or brownish dots or reticulations. The pustules on the rump and back are more developed in the paratypes. The ventral coloration is the same in all. The type and one paratype both have the right choana abnormally narrowed.

Remarks. The three specimens were obtained from rainpools in scant forest during a light rain at night. They were calling when first observed and their bodies were inflated enormously, causing them to look like some monstrous *Hypopachus* save for the inflated, spherical, balloon-like vocal sacs behind the jaw angles. In such a disguise I did not suspect their true relationship when they were first encountered.

There is much confusion in the concept of *"Hyla venulosa."* Adequate series of specimens from South and Central America will doubtless prove the presence of several legitimate species in the large synonymy of that form as indicated in Boulenger, Neiden, and other authors. It would appear that the key character "vocal sacs behind jaws" has been responsible for the unwarranted synonymyzing.

One Central American species of this group examined has the vomerine and palatine bones covered with curious dentate rugosities. This species may be *Hyla paenulata* of Brocchi, but this cannot be ascertained at this time.

I am of the opinion that *"Rana venulosa"* Laurenti, of unknown provenance, is unrecognizable, and the type figure might apply to several known species of the genus.

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PLATE No. IX. *Acrodytes inflata* sp. nov.

FIG. 1. Type, dorsal view about natural size, EHT-HMS No. 17890, La Venta, Guerrero, Mexico.

FIG. 2. Same. Head, lateral view. (× 1)

FIG. 3. Same. Hand, ventral view. (× 1)

FIG. 4. Same. Foot, ventral view. (× 1)

PLATE IX

THE UNIVERSITY OF KANSAS
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A New Land Tortoise, *Testudo riggsi*, from the Middle Pliocene of Seward County, Kansas

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ABSTRACT: A new small land tortoise, *Testudo riggsi* sp. nov., is described from a middle Pliocene deposit in Seward county, Kansas. It constitutes a part of the local Saw Rock Canyon fauna.

INTRODUCTION

IN June, 1943, while engaged in coöperative geological work in Seward county, Kansas, with Doctor Thad McLaughlin, of the United States Geological Survey, we discovered fossil remains of two specimens of a small turtle. While turtle remains are probably as numerous as the remains of any other vertebrate in the Pliocene and Pleistocene of Kansas, they are as a rule broken and disarticulated so that only fragmentary parts of an individual are ever recovered. These fragments seldom warrant collecting since only rarely are they identifiable. However, the finding of these two specimens and their associated fragments gave promise to the securing of nearly complete individuals. The surrounding areas were carefully searched for all pieces of each individual. The associated parts of the carapace and plastron of each individual when found were disarticulated at the sutures and greatly fractured along the deep sulci which were present where the scutes meet, thus producing a thin structure in the heavily developed carapace. In the laboratory with tedious efforts the shells were pieced together. The restored carapace is slightly warped. Due to the broadly arched carapace the peripheral bones are nearly hidden from the dorsal view. I am greatly indebted* to Mr. Elmer S. Riggs, Honorary

* I wish to express my gratitude to Doctor E. H. Taylor for numerous helpful suggestions and criticism in the course of the study of these specimens.

Curator of Vertebrate Paleontology, who has generously given his time for the past year in helping with Museum and Field Work and especially for his painstaking labor in helping me in the reconstruction of the two specimens here reported. The species is named in his honor.

Testudo riggsi sp. nov.

Holotype. Kansas University Museum of Vertebrate Paleontology, No. 6789, a nearly complete carapace and plastron, of an adult turtle, showing 14 lines of growth. *Paratype,* No. 6790, complete plastron and nearly complete carapace, and parts of skeletal elements of an adult with 16 lines of growth.

Horizon and type locality. Middle Pliocene, Locality No. 6, Seward county, Kansas. Saw Rock Canyon fauna.

Diagnosis. Probably the smallest of the known fossil species of *Testudo* from North America; superficially resembling *Gopherus berlandieri* (Agassiz), being of about the same size, although possessing a much heavier carapace and plastron that are rugose in appearance due to lines of growth: gular portion of the epiplastron decidedly thicker; distinguished from known species of *Testudo* by its small size and the high broadly arched carapace.

Description of type. A land tortoise with a carapace length of 176 mm.; carapace width of 155 mm. or 82 percent of its length. The height of the carapace is 85 mm., or 48 percent of its greatest length. Greatest length of the plastron is 189 mm., and the greatest width is 140 mm. The scale and bone formulae of the carapace and plastron are as follows: Scutes: 1 nuchal, 5 vertebral, 1 pygal, 4 costals, 11 marginals, 1 gular, 1 humeral, 1 pectoral, 1 axillary, 1 abdominal, 1 inguinal, 1 femoral, 1 anal. Bones: 1 nuchal, 8 neurals, 1 suprapygal, 1 pygal, 8 costals, 11 peripherals, 1 epiplastron, 1 entoplastron, 1 hyoplastral, 1 hypoplastral, 1 xiphiplastron.

The carapace is decidedly convex with the lip or gular lobes projecting well in front of anterior margin of the carapace. The nuchal scute is well developed. The surface of the bone of the first costal scute on the right side has fourteen concentric lines of growth, which are deep and well formed. The fifth costal bone is rectangular in shape, being as wide at the distal end as at the proximal end. The seventh costal bone has a width of 22.8 mm. at the distal end as compared to a width of 12.6 mm. at the proximal end. There is only one suprapygal bone although it is broken where it joins the eighth neural bone and the suture is destroyed. The suprapygal

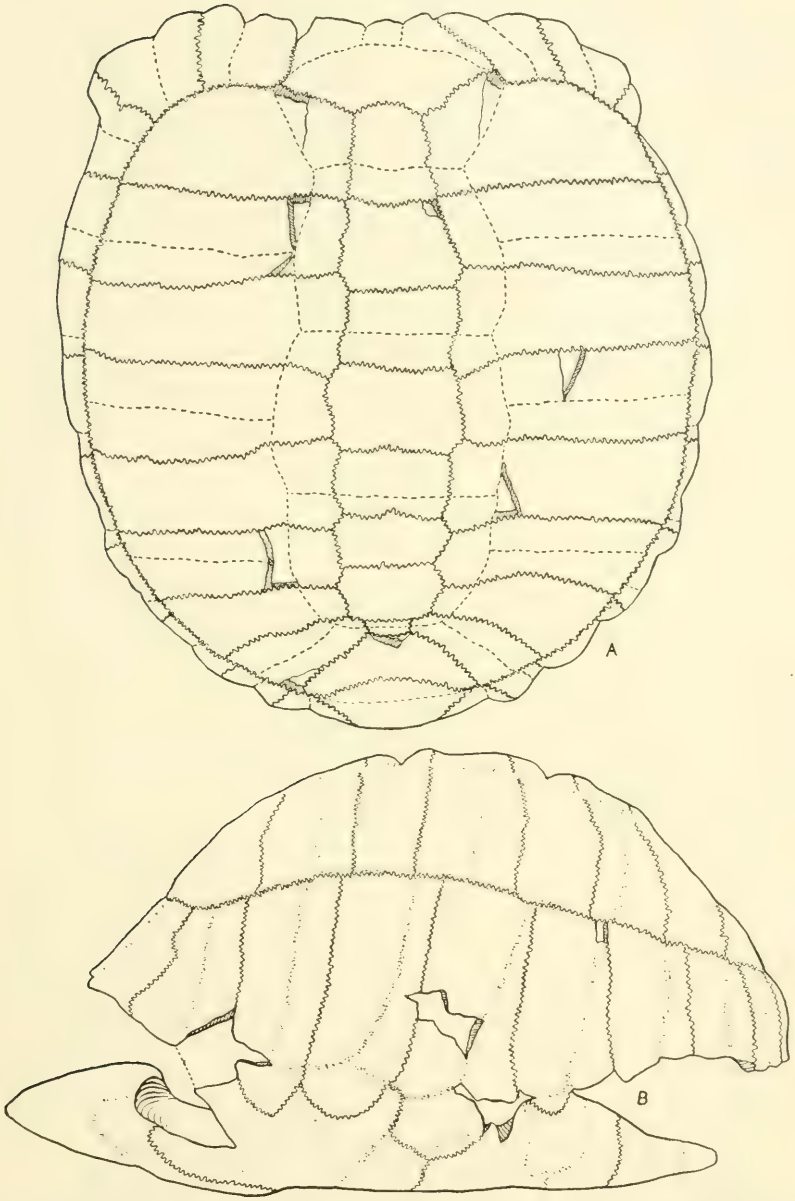

FIG. 1. *Testudo riggsi*, sp. nov. Type No. 6789, Kansas University Museum of Vertebrate Paleontology, Middle Pliocene Seward county, Kansas. A, dorsal view. B, lateral view. Drawings by Miss Barbara Barto.

is concave along its posterior border and joins the pygal bone which is convex anteriorly. The sulcus of the fifth vertebral scute crosses well down on the pygal bone. This region is similar to that figured by Hay[1] (1908, p. 429, fig. 561.) in *Testudo osborniana* Hay, specimen No. 5871 A. M. N. H. The free margin of the pygal bone is 9.5 mm. wide forming a slight indention in relationship to the adjoining free ends of the peripheral bones. The free borders of the peripherals are deeply notched and obtuse posteriorly, the greatest thickness being 16.5 mm. The greatest thickness of the anterior peripherals is 23.0 mm. The inguinal buttress extends but slightly above the costo-peripheral sature, though it is further expressed by a ridge on the inner surface of the sixth costal bone, extending approximately three-fourth of the distance along the midline of its inner surface. The ribs and vertebrae are missing.

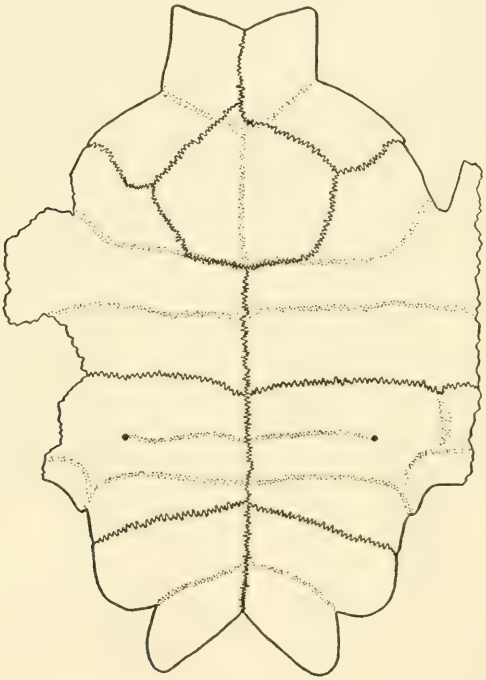

FIG. 2. *Testudo riggsi*. sp. nov. Ventral view of plastron of type No. 6789, Kansas University Museum of Vertebrate Paleontology. Drawing by Miss Barbara Barto.

1. Hay, O. P. 1908, The Fossil Turtles of North America, Carnegie Institution of Washington. Publ. No. 75, 568 pp, 113 pls., 794 figs.

Measurements of type and paratype

	Type	Paratype
	mm.	mm.
Total length of carapace	176.0	185.0
Greatest width of carapace	155.0	165.0
Greatest height of carapace	85.0	———
Length of bridge	81.5	85.0
Anteroposterior length of nuchal bones	37.1	42.5
Greatest width of nuchal bones	47.9	46.8
First neural bone (greatest length and width)	25.4–20.2	———
Second neural bone (greatest length and width)	20.9–26.6	———
Third neural bone (greatest length and width)	17.0–24.8	———
Fourth neural bone (greatest length and width)	19.5–28.8	———
Fifth neural bone (greatest length and width)	16.1–25.2	———
Sixth neural bone (greatest length and width)	15.2–27.5	———
Seventh neural bone (greatest length and width)	15.8–23.6	———
Eighth neural bone (greatest length and width)	11.4?–10.2	———
Suprapygal bone (greatest length and width)	34.0–42.6	———
Pygal bone (greatest length and width)	28.2–44.0	———
First costal bones (greatest length and width)	58.0–32.3	58.3–35.5
Second costal bones (greatest length and width)	62.0–24.0	———
Third costal bones (greatest length and width)	68.0–19.3	———
Fourth costal bones (greatest length and width)	67.8–23.6	———
Fifth costal bones (greatest length and width)	70.5–19.3	———
Sixth costal bones (greatest length and width)	59.0–19.6	———
Seventh costal bones (greatest length and width)	56.4–21.8	———
Eighth costal bones (greatest length and width)	36.3–16.0	———
First marginal bone (greatest length and width)	27.5–23.8	———
Second marginal bone (greatest length and width)	29.7–29.9	———
Third marginal bone (greatest length and width)	32.3–24.2	———
Fourth marginal bone (greatest length and width)	——23.4	———
Fifth marginal bone (greatest length and width)	———	———
Sixth marginal bone (greatest length and width)	———	———
Seventh marginal bone (greatest length and width)	44.9–23.8	———
Eighth marginal bone (greatest length and width)	37.9–22.0	———
Ninth marginal bone (greatest length and width)	27.0–23.5	———
Tenth marginal bone (greatest length and width)	32.0–20.0	———
Eleventh marginal bone (greatest length and width)	27.0–23.1	———
First vertebral scute (greatest length and width)	41.8–51.0	———
Second vertebral scute (greatest length and width)	35.5–46.5	———
Third vertebral scute (greatest length and width)	36.8–51.9	———
Fourth vertebral scute (greatest length and width)	37.0–46.5	———
Fifth vertebral scute (greatest length and width)	36.9–54.5	———
First costal scute (greatest length and width)	50.4–44.5	51.9–48.5
Second costal scute (greatest length and width)	56.5–37.3	———
Third costal scute (greatest length and width)	56.3–37.0	———
Fourth costal scute (greatest length and width)	45.5–42.5	———
Greatest length of plastron	189.0	195.0
Length of plastron in midline	162.0	173.0
Width of plastron at axilla	105.0	105.0
Width of plastron at inguinal border	90.0	100.0
Length of free lateral margin of gular bone	22.0	25.0
Width of base of both gular lobes	41.5	43.5
Greatest thickness of gular lobes	27.4	29.7
Width of emargination of anterior gular lobes	36.0	17.0
Depth of emargination of anterior gular lobes	6.4	3.5
Greatest anteroposterior length of entoplastron	45.2	44.0
Greatest width of entoplastron	48.0	42.3
Greatest anteroposterior length of hyoplastral	65.4	68.1
Greatest width of hyoplastral	72.2	69.2
Greatest anteroposterior length of hypoplastral	51.3	57.5
Greatest width of hypoplastral	66.3	68.2
Width of xiphiplastron on anterior suture	44.6	49.3

	Type mm. Type	Paratype mm. Paratype
Length of xiphiplastron on median suture	30.5	29.6
Width of emargination of anal lobes	39.0	42.8
Depth of emargination of anal lobes	16.0	22.0
Greatest thickness of anal lobes	10.4	11.5

The paratype agrees with the type, except that it is slightly larger. There are other slight differences between the two specimens which may be individual variation, but which I have considered as sex differences. The type appears to be a male with the entoplastron thicker and flatter and a well-developed prominence posteriorly where the entoplastron joins the pectoral sulcus. The gular lobes or the lip are not as flared nor the emargination as deep as in the type. The paratype has a wider and deeper emargination in the xiphiplastron with the free edges thinner than in the type. The pits where the ischia rests on the xiphiplastron are relatively shallower. A few skeletal elements were recovered with the paratype although only the femurs are complete. These have an overall length of 54.9 mm.

Remarks. Although the skull is unknown the species has been assigned to the genus *Testudo* rather than to the genus *Gopherus* for the following reasons. (1) The bones of the carapace and plastron are deeply sculptured by lines of growth, a condition unknown in *Gopherus*. (2) The carapace and plastron are very thick in comparison with those of *Gopherus*. (3) The peripheral bones are obtuse and deeply grooved by the sulci of the scales and much thicker than those observed in *Gopherus*. (4) The costal bones are equally as wide or wider distally, than proximally, while in specimens of *Gopherus* examined (*G. agassizii* (Cooper) and *G. berlandieri*) the fifth and seventh costal bones are considerably narrowed distally and are tapering instead of rectangular in shape. (5) Only one suprapygal is present which is concave at the distal end instead of two which occur in *Gopherus*, the second being convex distally. The pygal in the fossil species is convex at the proximal end and extends well above the costo-peripheral sulcus while in *Gopherus* the pygal extends to the costo-peripheral sulcus.

Associated forms found in the deposit with *Testudo riggsi* were the specimens of *Pliomastodon adamsi* Hibbard, *Osteoborus progressus* Hibbard, numerous beaver teeth of the genus *Dipoides*,[2] and abundant mollusks. The associated invertebrates and vertebrates from this locality are designated as the Saw Rock Canyon (local) fauna.

2. The beaver teeth were sent to Doctor R. A. Stirton, Curator of Vertebrate Paleontology, University of California, for verification. In a letter of August 6, 1943, he writes, "The specimens from Seward county, Kansas, seem to be clearly referable to the *sigmodus-williamsi* group of the genus *Dipoides*. This animal appears to be a well advanced Middle Pliocene form."

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A New Polycotylid Plesiosaur

By E. S. RIGGS

ABSTRACT: A new specimen of plesiosaur from the Greenhorn Limestone formation of Kansas is described and figured as *Trinocromerum willistoni:* sp. nov. The skull, vertebrae, shoulder and pectoral girdles are described and figured.

AN important specimen of Cretaceous plesiosaur, recorded as No. 5070 in the University of Kansas Museum of Vertebrate Paleontology, has been turned over to this writer for study and description by the Curator, Dr. Claude W. Hibbard. Recognition of this courtesy and of the assistance of Miss Dorothea Franzen, staff artist, in preparing figures of the specimen is hereby acknowledged.

The specimen was found by a road crew in December, 1936, while making a cut on U. S. highway 81 south of Concordia, Kansas. The location is Sec. 16, T. 6 S., R. 3 W.; the horizon is 10 feet below the Jetmore Chalk member in beds which, farther west of this area, have been classified as the Hartland Shale member, Greenhorn Limestone formation, Cretaceous series.

The specimen consists of a skull wtih mandible, fifty vertebrae, many ribs, most of the pectoral girdle, both pubes lacking some sections, and the ischia almost entire. There are no paddle bones. The specimen is fairly well preserved, but is compressed and distorted in various parts. Owing to the greater elongation of the dental series, the absence of a well-defined inter-clayicular foramen and other lesser characters which will be pointed out in the detailed description, this specimen is designated as a new species. In recognition of the important work on the plesiosaurs of Kansas and elsewhere by the late Professor S. W. Williston, the name of *Trinacromerum willistoni* sp. nov. is proposed.

Trinocromerum willistoni sp. nov.

Type. University of Kansas Museum of Vertebrate Paleontology No. 5070. Skull with mandible, fifty vertebrae, many ribs and most of the pectoral girdle.

Type locality. Sec. 16, T. 6 S., R. 3 W., in a cut on U. S. highway 81 south of Concordia, Kansas.

Horizon. Ten feet below the Jetmore Chalk member in beds which, farther west of this area, have been classified as the Hartland Shale member, Greenhorn Limestone formation, Cretaceous series.

Diagnosis: Related to *Trinocromerum osborni,* but differing in having the premaxillaries extending farther back; in having a larger maxillary tooth series (at least 34 as compared to a possible 26), interclavicle relatively much larger, and lacking the large foramen.

Description of the type. The *skull* is long and tapering with narrow face and short cranium, similar to that of the well-known holotype of *Trinacromerum osborni* Williston (K. U. M. V. P. No. 1300). The specimen under study has the appearance of a fully mature individual, while the holotype of *T. osborni* shows a number of juvenile characters. The skulls of both specimens are laterally compressed. That of *T. osborni,* being preserved in the chalk, has a better surface texture and the sutures are quite readily recognized, while the former has suffered many minute fractures. These fractures, together with the more complete ossification, due to advanced age of the individual, make it difficult to trace some of the sutures. (*See* Fig. 1.)

The *premaxillaries* are long and narrow, extending backward to a point beyond the center of the orbit. The median articulation is well marked through the greater part of its length, but in a space of 100 millimeters anterior to the orbit it is lost in the relatively smooth and well-rounded surface. The articulation with the maxillaries and the nasal bones is less distinct, but traceable forward to a point

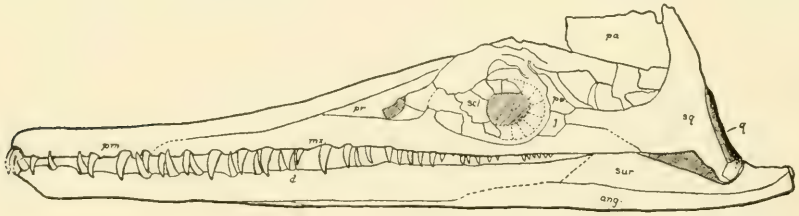

FIG. 1. Skull of *Trinacromerum willistoni* sp. nov., No. 5070, left side view. pm, premaxillary; mx, maxillary; pr, prefrontal; pa, parietal; po, postorbital; sq, squamosal; q, quadrate; d, dentary; ang, angular; sur, surangular.

above the seventh tooth, where it is lost. The posterior extremity of this bone is laterally compressed and terminates in a wedgelike form, enclosed between two laminae of the frontal bones. It differs from that of *T. osborni*, as described by Williston, in extending farther backward and in the evident characters of a more mature individual.

The *maxillaries* extend beyond the middle of the temporal arch. They are characterized by the very elongated dental series, including no less than thirty-four teeth as compared with a possible twenty-six in *T. osborni*. The teeth are uniformly large to a point about the middle of the series, then steadily decrease in size and in the interval separating them. The series terminates at a point below the posterior margin of the orbit, leaving an edentulous border of 70 millimeters. The greatest breadth of the maxillary is near the middle of the dental series; below the orbit is narrows to a diameter of 13 mm.

The *frontals* are not distinctly marked in their outlines. They apparently enclose and overlap the posterior extremity of the premaxillaries. There are, above the orbits, a pair of relatively prominent and rugose superciliary crests whose homologies are doubtful. In this specimen these crests are compressed, so that the superior wall of the orbit appears on the lateral surface. Neither the anterior nor the posterior articulations of the frontals has been determined.

The *parietal bones*, though laterally compressed in this specimen, were doubtless quite narrow. They present a thin vertical crest, extending backward from a point above the orbit. Whether or not they meet the premaxillaries remains in doubt.

The area, anterior to the orbit which should include the *lachrymals* and the prefrontals is too badly fractured to admit of accurate description. The anterior part of the prefrontal is seen at the angle between the maxillary and the premaxillary.

The *squamosal*, as figured in many plesiosaurs, is a broad, branching bone with its posterior margin articulating with the quadrate and sending a superior branch upward so as to overlap the parietal and apparently meet its fellow in a crest. The anterior branch, more broad and flattened than the other, forms the greater portion of the temporal arch. There is no evidence of a quadratojugal element in this specimen and in deference to Williston's later conclusion that this bone does not occur in plesiosaurs,[1] no indication of its presence has been made on the accompanying drawing. How-

1. (Trinocromerum. Jour. of Geol. Vol. 16, 1908, p. 715.) (Osteology of the Reptiles, Harvard Univ. Press, 1925, p. 56.)

ever, it is observed that S. P. Welles[2] in a recent monograph on "Elasmosaurid Plesiosaurs," definitely described and figured it as present in *Hydrotherosaurus* and *Thalassomedon*.

The *quadrate* is a strong bone joining the squamosal posteriorly at a right angle and presenting its broad surface on the posterior aspect of the skull.

The *angular* extends forward beyond the middle of the dentary where it overlaps a small portion of the splenial as exposed in the lateral view.

The *mandible* is long, straight on its inferior border and tapering in breadth from the coronoid eminence to its anterior extremity. It articulates with the quadrate in an elongated glenoid fossa; the posterior member is strongly recurved and truncate at the extremity. The dentary bone is plainly marked, extending posteriorly to a point some 40 mm. from the end of the opposing maxillary. The dentition can be traced no farther than to a point below the center of the orbit, probably because of the imperfect preservation of the specimen. The surangular, is somewhat broader than the angular. The articular apparently does not project beyond the glenoid fossa so as to be seen on the lateral surface.

Measurements	mm.
Skull, alveolar border to occipital condyle	640
Skull, alveolar border to quadrate	692
Skull, length of maxillary	594
Skull, length of upper dental series	513
Skull, greatest breadth of maxillary	32
Skull, least breadth of maxillary	13
Mandible, greatest length	745
Mandible projection, posterior to articular surface	55
Mandible, depth at coronoid eminence	65

Some fifty vertebrae are included in this specimen, many of them entire though more or less laterally compressed. Of this number, fifteen are cervicals, including the atlanto-axis complex and the four succeeding cervicals in series.

The *atlas* and *axis* are combined to form one piece and, due to the mature age of this individual, are more or less coössified. Some of the sutures described by Williston in the holotype of *T. osborni* do not appear in this specimen. (*See* Fig. 2.)

The atlas consists of five parts: Two paired neurapophyses, two subtriangular odontoids and a single massive intercentrum. The neurapophysis of the right side is preserved, the left being separated from it at the median line and lost. This is a relatively broad, flat

2. (Memoirs Univ. of Calif., Vol. 13, No. 3, 1943, pp. 133-157.)

bone which presents a small concave, anterior surface to the occipital condyle of the skull and joins by suture with the odontoid which has not been recovered in this specimen. Posteriorly, it joins the atlantar neurapophysis in a vertical suture. Superiorly it terminates in a short and laterally flattened, spinelike process; at the inferior extremity it joins the intercentrum. The axial intercentrum is a strong bone, having a hemispherically concave facet at its anterosuperior surface. It occupies a median position and supports the occipital condyle from below. The inferior surface bears a slight median keel which extends along the posterior half of its length. It articulates posteriorly by suture with the axial intercentrum.

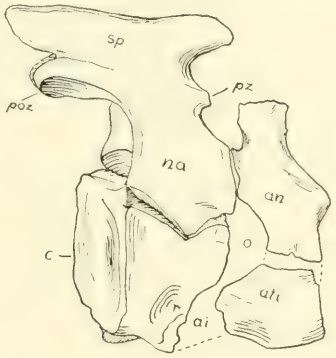

FIG. 2. Atlanto-axial complex. na, axial neurapophysis; c, centrum; ai, axial intercentrum; r, axial rib; pz, prezygapophysis; poz, postzygapophysis; an, atlantar neurapophysis; ati, axial intercentrum; sp, neural spine.

The *axis*, in its lateral aspect, approaches the general outlines of a typical cervical vertebra of this animal. It may be distinguished by the elongated neural spine, by the vestigeal prezygapophysis and by the much reduced axial rib. The axial intercentra are paired bones, each of which joins an odontoid anteriorly and which extends posteroinferiorly, forming a part of the rib attachment and meeting the axial centrum in a curved suture. The axial rib, which is firmly coösified on the left side, is mostly broken away from the right. It is rounded, tapering and fanglike in form. The centrum is the larger and more massive part of this vertebra. Posteriorly, it presents a typical vertebral articulating surface to the succeeding cervical; superiorly it forms two-thirds of the footing of the neural pedicle.

The succeeding cervical vertebrae have moderately amphicoelous centra throughout and gradually increase in size as they approach the dorsal series. The sutures joining the pedicles and the cervical

ribs to the centra are plainly marked. The centra are apparently higher than wide. Their lengths are approximately equal to their height throughout.

Length of cervical centra, 26 mm. to 42 mm.

Greatest length of dorsal centra, 53 mm.

Pectoral girdle. The scapula is preserved on the left side only. (Fig. 3.) It is of the typical triradiate form, common to plesiosaurs. Though distorted by compression, it was evidently quite concave on the mesial surface and marked by a strong, rounded crest which forms the long axis of the bone. It is about one-fifth longer and correspondingly broader than the same in the type specimen of *T. osborni*. The proximal articular end, as seen in the lateral view,

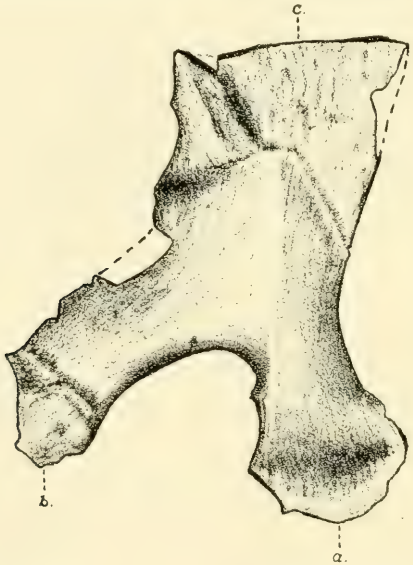

FIG. 3. Scapula, lateral view. a, brachial articulation; b, mesial branch; c, axial border.

is uniformly rounded, in decided contrast with the two distinct facets observed in the smaller species. The mesial border is less strongly concave; the distal end is broad and presents a slightly curved extremity for cartilaginous attachment. The lateral ramus terminates in a surface moderately thickened and angular in outline, as seen from the lateral view.

The *clavicles* (Figs. 4, 5,) are both preserved, the right one almost in entirety, the left in normal relation with its fellow, but crumpled and broken in the lateral half. All of these parts are flattened from

compression in the matrix so that the natural concave form of the superior surface has been, to a large extent, lost. The two bones are separated anteriorly by a wide interval, filled in by the interclavicals. Posterior to this, the two elements join at the median

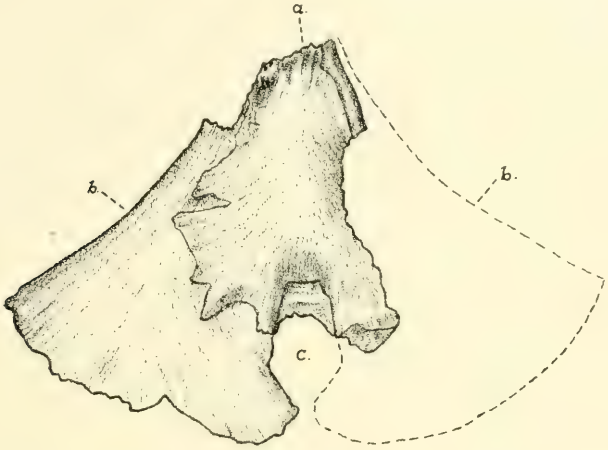

FIG. 4. Clavicles and interclavicle, ventral view. a, interclavicle; bb, clavicles; c, interclavicular vacuity.

line in a serrated suture some 40 millimeters in length. Beyond this, and in the median line, is an irregular vacuity bounded by plates so thin and irregular in outline as to preclude the probability that this was a functional opening, homologous to the large inter-

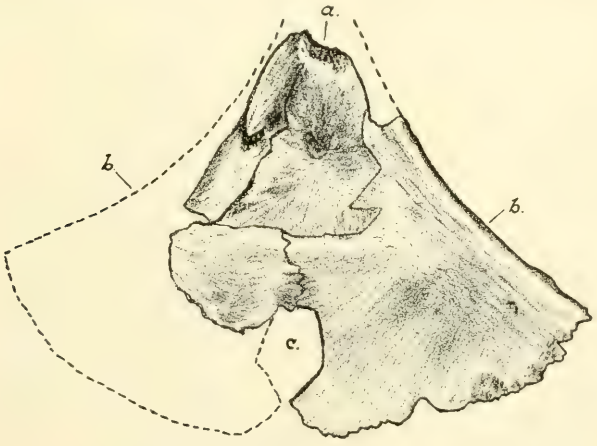

FIG. 5. Clavicles and interclavicle, visceral view. a, interclavicle; bb, clavicles; c, interclavicular vacuity.

clavicular foramen described by Williston in *T. osborni* and erroneously described by Cragin (1888) as the pineal foramen of the cranium.

Each of the *clavicles* sends forward a narrow platelike branch which slightly overlaps the lateral surface of the interclavicle and may have joined anteriorly in the median line. Small parts missing from this section make it impossible to say what structure the anterior extremity of clavicles and interclavicles may have had.

The *interclavicle* is a thick and strong plate, concave on the

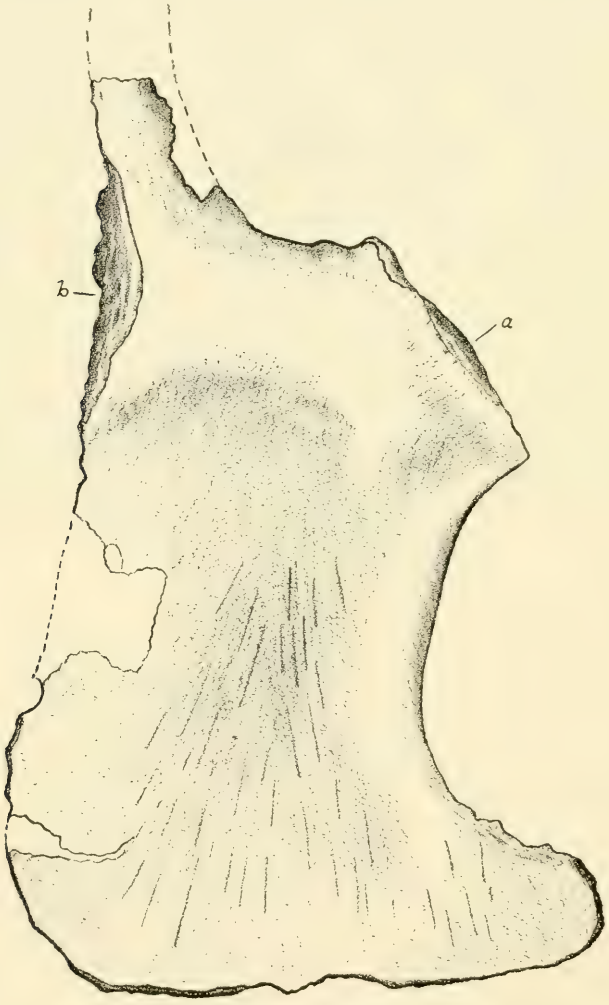

FIG. 6. Right coracoid, visceral view. a, brachial articulation; b, mesial border.

superior surface and rather strongly covex on the inferior. It lacks the prominent ridges which mark the inferior surface of this bone in the smaller species. The lateral margins are deeply serrated where they overlie the clavicles. A median indentation appears at the posterior border similar to that figured in *T. anonymum* Williston. It corresponds with the large interclavicular foramen in *T. osborni* and in *T. bentonianum*[3] Cragin. The much greater relative size of this element, together with the absence of the large foramen, clearly distinguish this specimen from *T. osborni* and *T. bentoni-*

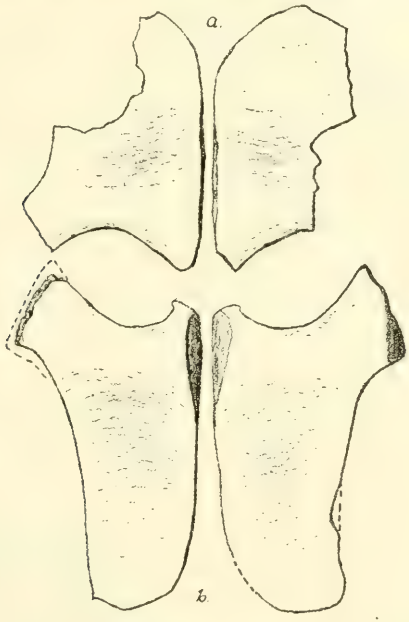

FIG. 7. Pelvic girdle. a, pubes; b, ischia.

anum. The small parts of *T. anonymum,* so far described, leave doubt as to its homologies.

The *coracoids* (Fig. 6) are well preserved in this specimen, the right one almost entire, the left broken into large sections with missing parts. As in *T. osborni,* the coracoids are broad, flat bones which present a lateral shoulder to the glenoid fossa, and are outlined by curved lateral borders and truncated posterior ends, each with a broad, lateral projection, and a straight margin at their median juncture. The glenoid articulation, forming the joint for

3. (N. A. Plesiosaurs, Williston 1903.)

the fore limb, is reinforced by a strong transverse thickening which produces a convexity on the superior surface. A narrow bar, partly broken in this specimen, extends forward from the anteromesial angle to meet the posterior margin of the clavicle. The small foramina appear near the mesial border of each.

Measurements	mm.
Scapula, axial length	254
Scapula, greatest breadth of glenoid ramus	90
Scapula, estimated breadth of upper ramus	135
Scapula, greatest breadth across glenoid and superior rami	222
Interclavicle, length at median line	118
Interclavicle, greatest breadth (estimated)	145
Clavicle, breadth of left, from interclavicular suture	165
Coracoid, axial length of incomplete bone	470
Coracoid, greatest breadth at glenoid articulation	235
Coracoid, greatest breadth at posterior end	430

Pelvic girdle. The pelvis, as in most plesiosaurs, is less characteristic than the pectoral girdle. The pubes are more or less broken. They are broad, platelike bones, rounded in the anterior half of the median borders, slightly thickened and convex on the superior surface opposite the femoral articulation. (See Fig. 7, 8.)

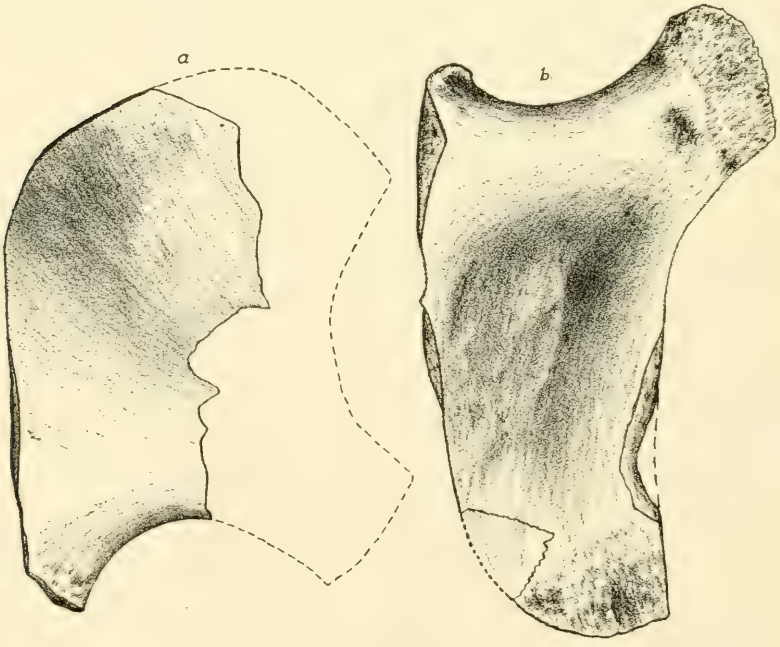

FIG. 8. Pelvic bones. a, right pubis, visceral view; b, right ischium, visceral view.

The *ischia* are almost entire. The anterior ends are convex on the superior surfaces and appreciably thickened to form a transverse bar to support the rear paddles. The greater, bladelike area is concave on the superior surface with the lateral margin considerably elevated.

Measurements	mm.
Pubis, greatest length near median line	275
Pubis, breadth of incomplete bone at femoral articulation	195
Ischium, greatest length over all	360
Ischium, breadth across anterior end	205

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Remains of Birds from the Rexroad Fauna of the Upper Pliocene of Kansas

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ABSTRACT: From fossil bird remains from the Rexroad Fauna of the Upper Pliocene of Kansas, the following species are described as new: a duck, of the genus *Nettion*, a quail, genus *Colinus*, and a rail, genus *Rallus*. Aside from the described species, twelve other forms are recognized, four of which are referred to living species. The remaining forms are based on material too fragmentary to permit of specific identification.

THE Upper Pliocene deposits of Meade county, Kansas, through exploration by C. W. Hibbard, Curator of Vertebrate Paleontology at the University of Kansas and his assistants from 1936 to 1940, have given quantities of bones of the smaller vertebrates, the remains of mammals being especially abundant. With these there have been obtained many fragments of the skeltons of birds that Doctor Hibbard from time to time has forwarded to me for study. This report embodies the results of this work to date.

In brief résumé, these fossil deposits were first located in 1935 by men from a Civilian Conservation Corps camp who noticed various bones during quarry work in connection with a state lake project. They uncovered several large skeletons that were swept away and destroyed by a cloudburst. Doctor Hibbard came to the region in the summer of 1936, noted the smaller bones remaining, and began the careful sifting of the dump and the remaining deposits. The work continued during the summers from 1937 to 1940, with an extensive collection as the result. The present paper is the first report on the bird material obtained.

According to the account of Doctor Hibbard the region investigated lies along the valley of a stream tributary to Crooked creek

where the bird material was obtained at points designated as Locality 2 and Locality 3. Upper Pliocene deposits are found here in isolated areas, being exposed where streams have cut through the overlying strata of the Pleistocene. The bones are found in sand, sandy silt, clay, and bog material, with the sand in places consolidated. The bird bones in the main have come from the sandy areas, are light in color, and are easily broken. Occasional specimens are blackish brown, indicating deposition in boggy areas. Doctor Hibbard has designated the aggregation of species found in these Pliocene beds as the Rexroad fauna, and after analysis of the 32 identified species of mammals has indicated that this fauna has the approximate age in the upper Pliocene of the Blanco, Benson and Hagerman deposits, with closer affinity to the Blanco and Benson faunas.[1]

Bones of birds from the Pliocene of North America for years were rarely found, and as yet the life of this age is poorly represented in our lists in comparison with that of the Miocene and the Pleistocene. The present collection is one of the most important that has been obtained as it gives the largest number of forms from a single locality. As the specimens were secured by sifting that saved the smallest pieces many are too fragmentary for successful identification. However, a fair number have been named, giving much useful information. Three species are described as new, a quail, a teal and a rail. There are fragments of several other species that are unknown to science, but that are represented by such fragmentary material that definite description is not warranted. I see no point in naming bones, that while obviously from unknown species, cannot be placed generically with the material available. Such indiscriminate naming is confusing, and is always a hindrance in subsequent studies when other specimens in the same groups become available.

The bones in this collection from the species of the Order Passeriformes present a problem as yet unsolved. This order in the avian class has a far greater aggregation of living species than any other, and there can be no question but that the multitude of forms was even more extensive in the later part of the Tertiary. Osteological differences among these are present but are often obscure. In the Rexroad material it is possible to segregate bones belonging to the

1. For further details and fuller bibliography see the following papers:
Hibbard, Claude W., Paleoecology and correlation of the Rexroad Fauna from the Upper Pliocene of southwestern Kansas, as indicated by the mammals. Univ. Kansas Sci. Bull., vol. 27, No. 6, November 1, 1941, pp. 79-104, 1 text fig.

Frye, John C., and Hibbard, Claude W., Pliocene and Pleistocene stratigraphy and paleontology of the Meade Basin, southwestern Kansas. State Geol. Surv. Kansas, Bull. 38, December 5, 1941, pp. 389-424, 4 plates.

Fringillidae that are not like those of available skeletons of existing kinds, but of the several hundred species of this family recorded from the New World only a small part of those found now to the south of the United States are at present available. More than 175 species with several times that number of geographic races are known from North America and Central America, with a much larger group in South America. These are distributed among more than 100 distinct genera. While only a relatively small part of these reach Kansas today there is no question but that the variety there was greater at the end of the Tertiary than at present. There is also the certainty that numerous groups have become extinct before our time. Under these circumstances it has been necessary to leave the detailed study of the Passeriform specimens for later consideration when a larger variety of modern skeletons is at hand.

Of the identified specimens more than one-half belong to aquatic species that live in and around marshes, streams and ponds. Remains of turkeys represent birds of wooded areas, while parrots, pigeons and quail are species of forests, or regions where thickets and groves grow amid plains, prairies or savannas. The passeriform birds may have lived in prairie land, in thickets or in forests.

Of great interest are four birds that have been identified with species living today, the Rexroad occurrence being their most ancient records, carrying them back through the Pleistocene into the Upper Pliocene. While we may accept these Rexroad bones as specifically identical with the living representatives we may speculate on differences in the feathers that may have marked them as subspecifically quite different.

Drawings illustrating the new species here described have been made for me by Sydney Prentice.

ANNOTATED LIST

ORDER COLYMBIFORMES. Grebes

FAMILY COLYMBIDAE. Grebes

Colymbus sp.

The material from Locality 3 obtained in 1937 includes the proximal third of a right tarso-metatarsus, No. 4484, from a grebe of the genus *Colymbus*. The bird is definitely smaller than *Colymbus auritus* and *C. nigricollis*, being similar in the size of the head of the metatarsus to *Colymbus chilensis* (Lesson), found today from southern Perú, Bolivia and Uruguay south through Argentina and Chile to the Straits of Magellan. The shaft, however, is decidedly

more slender. The bone represents an unknown species, but must for the present remain undescribed because of the incomplete material.

In 1938 the party secured at Locality 2 the distal half of a right coracoid, No. 4652, that possibly represents the same unknown species. This bone is smaller than the coracoid of *Colymbus nigricollis, C. auritus* or *C. occipitalis,* the last species being from southern South America, but is slightly larger than *C. chilensis.*

ORDER CICONIIFORMES. Herons, Storks and Allies

FAMILY THRESKIORNITHIDAE. Ibises and Spoonbills

Threskiornithid, sp. incert.

A left coracoid, No. 4741, with the sternal end missing, from Locality 3 is from an ibis smaller than *Plegadis* and *Guara.* The bone is highly interesting as it represents an unknown species probably allied to *Plegadis,* but from the fragment available the genus cannot be definitely determined. The species was one from one-fourth to one-eighth smaller than the modern white and scarlet ibises and the glossy ibises. The small size for a bird of this group is intriguing.

ORDER ANSERIFORMES. Screamers, Swans, Geese and Ducks.

FAMILY ANATIDAE. Swans, Geese and Ducks.

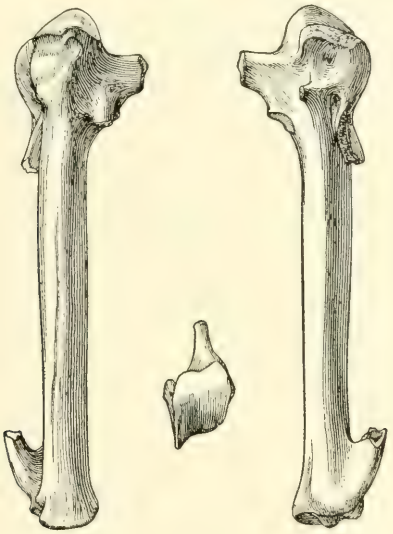
Nettion bunkeri sp. nov.

Characters. Carpo-metacarpus (figs. 1 to 3) similar to that of modern *Nettion carolinense* (Gmelin),[1] but metacarpal III and the proximal carpal trochlea distinctly heavier; metacarpal IV also heavier, as indicated by the proximal and distal unions with m III; facet for pollex larger.

Description. Type, right carpo-metacarpus with shaft of metacarpal IV missing, Kansas University Museum of Vertebrate Paleontology No. 3982, from Locality 3, Rexroad fauna, Ogalalla group, late Blancan age, Upper Pliocene, Meade county, Kansas, collected by Claude W. Hibbard and party in 1937. Carpal trochlea heavy, the internal one produced below in a sharp-edged compressed ridge; inner one with its lower margin notched so that its outline, as seen from behind, is definitely angular; a well-marked anterior carpal fossa, in form shallowly and irregularly cup-shaped; pisiform process moderate, but rising from a strong support that forms a straight-

1. *Anas carolinensis* Gmelin, Syst. Nat., Vol. 1, pt. 2, 1789, p. 533.

edged shelf at the base of metacarpal II, with another straight edge at right angles below, forming the distal margin of the internal ligamental fossa; metacarpal II compressed from side to side, with the point truncated and notched in front; facet for pollex expanded, with an irregular, rounded external projection; shaft of metacarpal III relatively strong, straight, rounded above and on its outer side, the inner and lower surface flattened, joining the outer face in an acute angle to form a long, straight ridge; tendinal groove faintly



FIGS. 1-3. Right carpo-metacarpus, type of *Nettion bunkeri*, twice natural size.

impressed; metacarpal symphysis, or fornix, relatively strong; metacarpal IV missing except at proximal and distal union with metacarpal III; distal end truncated. Bone lightly fossilized, light brownish white in color.

Measurements. Total length, 35 mm.; transverse width across carpal trochlea, 4.3 mm.; transverse width of proximal end of Metacarpal III, 3.6 mm.

Remarks. The specimen, except for heavier size, is a close counterpart of the living green-winged teal *Nettion carolinense*. The total length of the carpo-metacarpus is that of the male of the modern bird, and the length of the union of metacarpals III and IV is also the same. The heavier shaft and the heavier carpal trochlea are distinctive, as is the stronger pisiform process, and the broader,

stronger articulation for the pollex. Comparative measurements of a male of *Nettion carolinense* (U. S. N. M. No. 224,084) are as follows: Total length, 35 mm.; transverse width across carpal trochlea, 3.9 mm.; transverse width of proximal end of metacarpal III, 3.1 mm.

In its larger size then the fossil has something of the same relation to the living green-winged teal that *Querquedula floridana* Shufeldt, described from the Pleistocene of Florida, has to the modern blue-winged and cinnamon teal.

Study of this specimen has led to reëxamination of the proximal end of a right metacarpal, U. S. N. M. No. 10,936, collected by J. W. Gidley from the Benson local fauna of the Upper Pliocene, 2 miles south of Benson in the San Pedro Valley, Arizona. This bone in 1924 [2] I listed under the heading of *Querquedula*, species. In the twenty years since I first examined this specimen the National Museum collection of skeletons of modern skeletons of the Anatidae of the New World has been increased until adequate series of a number of species are at hand. These indicate that one of the differences in the carpo-metacarpus in *Querquedala* and *Nettion* is found in the metacarpal symphysis, which measures in length approximately 7 mm. or more in *Querquedula discors*, and 6.0 mm. or less in *Nettion carolinense*. The proximal end is quite similar in the two. The Benson fossil has the transverse measurement across the carpal trochlea 4.3 mm., and the transverse breadth of metacarpal III at its proximal end 3.7 mm. These measurements are definitely heavier than living *Querquedula discors* or *Q. cyanoptera*, and agree exactly with the fossil *Nettion bunkeri* from the Rexroad formation. The form of the pisiform process and the angles at its base are also identical. The specimen therefor is referred to *Nettion bunkeri*.

The species is named for Charles D. Bunker, of the Kansas State University Museum of Natural History, in recognition of his fruitful labor in building the collections long under his care, and of the writer's close association with him for many years.

Charitonetta albeola (Linnaeus) Bufflehead

A nearly complete tarso-metatarsus, No. 3984, was found at Locality 3. This specimen exhibits characters found in a series of eight skeletons of the modern bird, and from its size may have come from a female individual. The middle trochlea has the groove for the articulation of the basal phalanx very slightly broader, with the

2. Proc. U. S. Nat. Mus., vol. 64, art. 5, January 15, 1924, pp. 1, 3.

external flange at the distal end slightly lower, than in several of the modern specimens, but the condition is almost equaled in two others. The difference is very slight and is probably individual. In general conformation the fossil checks closely otherwise with the modern material.

The bufflehead has been reported previously from the Pleistocene of Fossil Lake, Oregon, and from the asphalt beds at McKittrick, California. The Rexroad specimen is the first record for the Pliocene.

The study of this Rexroad material has led to examination of certain other fossil specimens that I have identified in the past, among them three fragmentary metacarpals, U. S. N. M. No. 16749, from the Pleistocene of Florida, obtained by W. W. Holmes in Pinellas county, Florida. In 1931 [3] I listed these under *Querquedula floridana*, an extinct teal known from the Pleistocene beds of Florida. Since that time the National Museum has built up larger series of the skeletons of the Anatidae so that the characters of the skeleton may be better understood. On further study now it develops that two of the Pinellas county metacarpals in which metacarpal No. 3 and the distal fornix are practically complete are those of *Charitonetta albeola*. The third with the distal end missing may be referred to the same species. The record constitutes another locality for this species in the Pleistocene.

Anatidae, not identified

Bones of ducks are common in the Rexroad collection but except for the type of *Nettion bunkeri* and the specimen of the Bufflehead are too fragmentary for specific identification. Possibly five species are represented, perhaps one or two more, as indicated by size differences and other variations.

Three fragmentary humeri are slightly larger than living blue-winged or green-winged teal, as is one broken coracoid. Possibly these may have some connection with *Nettion bunkeri*, but this is uncertain.

Slightly larger ducks are represented by the worn distal end of a tibio-tarsus, and parts of a scapula, a coracoid, and an ulna.

There is a coracoid and a scapula of one still larger form, and the broken coracoid and part of a femur of another, the one last mentioned being a little smaller than a mallard.

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3. Smiths. Misc. Coll., vol. 85, No. 2, April 13, 1931, p. 22.

ORDER FALCONIFORMES. Vultures, Hawks and Falcons

FAMILY ACCIPITRIDAE. Hawks

Buteo sp.

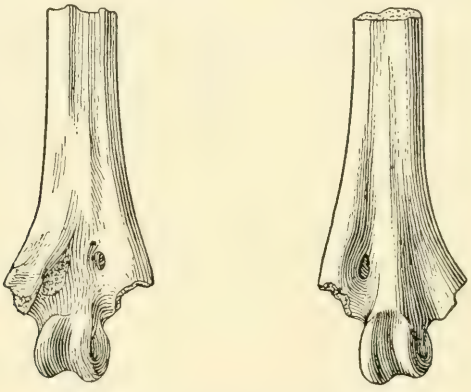
In miscellaneous bones secured in the season of 1937 there is the anterior end of a sternum, considerably worn, that comes from a large hawk about the size of the red-tailed hawk *Buteo jamaicensis*.

ORDER GALLIFORMES. Megapodes, Curassows, Pheasants and Hoatzins

FAMILY PHASIANIDAE. Partridges, Quails and Pheasants

Colinus hibbardi sp. nov.

Characters. Distal end of tarso-metatarsus (figs. 4 and 5) similar to that of modern *Colinus virginianus* (Linnaeus) [4] but decidedly larger; shaft stronger, and more heavily lined by the tendinal grooves.



FIGS. 4-5. Distal end of right tarso-metatarsus (fragmentary), type of *Colinus hibbardi*, three times natural size.

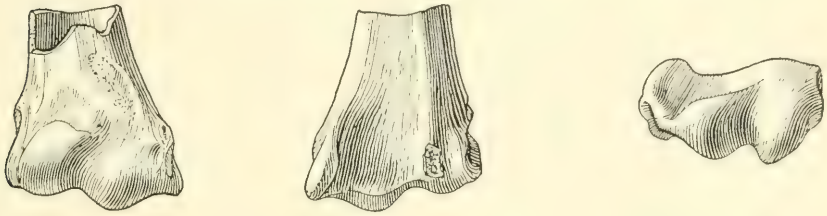
Description. Type, Kansas University Museum of Vertebrate Paleontology No. 3981, distal portion of right tarso-metatarsus, with the main parts of the outer trochlea missing, collected in 1937 from Locality 3, Rexroad Fauna, Ogalalla group, late Blancan age, Upper Pliocene, Meade county, Kansas, by Claude W. Hibbard and party. Shaft strong, flattened distally, with three sharply angular lines marking tendinal grooves on posterior surface; facet for hallux large and well marked; anterior face with a broad, shallow groove leading

4. *Tetrao virginianus* Linnaeus, Syst. Nat., ed. 10, vol. 1, 1758, p. 161.

down into the relatively large inferior foramen; outer trochlea missing except for the expanded base; middle trochlea strong, elliptical in lateral outline, with its lateral faces slightly excavated; a shallow groove extending clear around the articular surface, beginning in a definite depression on the anterior face; the outer flange bordering this groove slightly heavier than the inner, and on the posterior face extending farther up toward the inferior foramen; inner trochlea, with distal tip missing, strongly developed. Bone white, with a slight brownish tinge, well preserved though not heavily silicified.

Measurements. Transverse breadth of shaft below center, 3.1 mm.; transverse breadth across trochlea (approximate), 7 mm.; transverse breadth of middle trochlea, 2.9 mm.

REMARKS. In spite of its fragmentary condition it is readily evident that this specimen comes from a *Colinus*, and on comparison it



FIGS. 6-8. Distal end of right humerus, Kansas University Museum of Vertebrate Paleontology No. 3997, identified as *Colinus hibbardi*, three times natural size.

is so definitely large that there is no difficulty in separating it as a distinct species from the modern forms. Its characters are such as to place it with *Colinus* and to separate it from *Lophortyx* and *Callipepla*. *Lophortyx* differs in the more angular development of the posterior side of the middle trochlea. *Callipepla* has more slender form throughout. *Cyrtonyx* is decidedly different, as in spite of the stocky form of the shaft the trochlea are reduced in size.

The distal end of a right humerus, No. 3997, was secured at Locality 3, likewise in 1937. This specimen (figs. 6 to 8) is well preserved and little worn. In general it is like *Colinus virginianus* except for slightly larger size. The brachial depression is relatively larger, with the ridge bordering it longer, extending farther up the shaft. The bone has the size of an adult male of *Cyrtonyx montezumae mearnsi*, but the trochleae are definitely smaller. *Callipepla squamata* is fairly close to *Colinus virginianus* in the form of this

part of the humerus, but has the radial trochlea larger, this being actually about as large as in the fossil though the latter is from a bigger bird. *Lophorytyx californica* and *L. gambeli* have the brachial depression definitely smaller. In the fossil the transverse breadth across the trochleae measures 18 mm. In two *Colinus virginianus* this dimension is 16.7 and 17.1 mm. The difference in bulk is easily apparent on direct comparison.

The distal end of a left humerus, No. 4660, was collected in 1938 at Locality 2 in Meade county, a bone that is so badly worn that it can barely be identified. It also measures 18 mm. in transverse breadth across the trochleae, but offers no other points that are pertinent.

Study of these specimens has led to critical examination of *Colinus eatoni* Shufeldt[5] described from an unknown geological horizon in western Kansas. The type material according to Doctor Shufeldt consists of a left carpo-metacarpus and the proximal phalanx of an index digit. The description is brief, but from the illustration it appears that the metacarpal may come from some oscinine Passeriform bird, possibly an Icterid, or a Fringillid, a matter to be decided by examining the original bone. The digit may represent another species of bird. The species, therefore, is to be removed from the genus *Colinus*.

Colinus hibbardi is named for Claude W. Hibbard in recognition of his painstaking and careful work in developing the Rexroad fauna.

FAMILY MELEAGRIDIDAE. Turkeys

Meleagris gallopavo Linnaeus. Turkey

A left tibio-tarsus, with the shaft shattered in the region of the peroneal ridge, was obtained in Locality 3. This bone was broken but the fragments were present so that it could be repaired and restored until the conformation is as it was originally. The specimen is one of moderate to small size, and agrees in all of its characters with modern specimens of the wild turkey.

It is the first record of this species from the Pliocene.

Meleagrididae, sp. ?

The proximal third of a scapula, No. 3993, taken at Locality 3, in 1937, comes from a turkey-like bird of rather small size. It differs from the turkey, *Meleagris gallopavo,* and from the ocellated turkey, *Agriocharis ocellata,* in lacking a pneumatic foramen on the outer

5. Trans. Connecticut Acad. Arts Sci., vol. 19, February, 1915, p. 70, pl. 13, fig. 103.

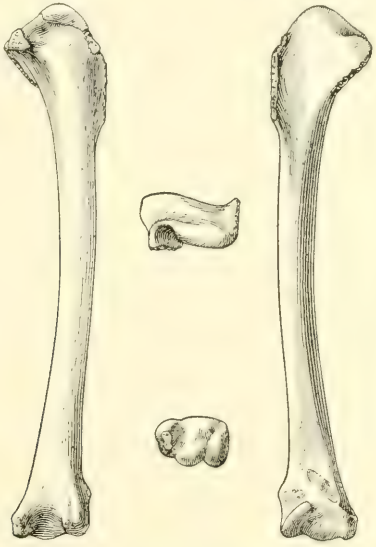
face between the furcular articulation and the glenoid facet. The form also is more slender. The generic identity of the bird represented by this fragment is uncertain. It may be noted that the specimen is very dark brown in color, quite different from the other bird bones in this collection, an indication that its method of preservation has been different.

ORDER GRUIFORMES. Cranes, Rails and Allies

FAMILY RALLIDAE. Rails, Gallinules and Coots

Rallus prenticei sp. nov.

Characters. Humerus (figs. 9-12) rather similar to that of modern *Rallus limicola Vieillot*[6] but slightly heavier; crista superior



FIGS. 9-12. Right humerus, type of *Rallus prenticei,* twice natural size.

longer and heavier; ectepicondylar prominence slighter; trochleae relatively smaller; entepicondylar prominence slighter.

Description. Type, right humerus, nearly complete, Kansas University Museum of Vertebrate Paleontology No. 3865, from Locality 2, Rexroad fauna, Ogallala group, late Blancan age, upper Pliocene, Meade county, Kansas, collected by C. W. Hibbard and party in 1936. Proximal end of bone averaging strong and heavy compared with related modern rails; head merging smoothly into shaft on

6. *Rallus limicola* Vieillot, Nouv. Dict. Hist. Nat., vol. 18, 1819, p. 558.

anconal aspect, with a strong external tubercle; capital groove in outline a rectangle, the bottom slightly excavated, slightly undercut at lower margin, otherwise with the walls rising at a right angle from the base; internal tubercle relatively strong (distal point missing); crista superior relatively long (free margin partly broken), with a prominent attachment for the pectoralis major; a considerable concavity on the anconal aspect below the internal tubercle, but no open pneumatic foramen; palmar aspect of head with a lightly marked deltoid groove; bicipital surface smooth, slightly convex; shaft fairly strong, with a slight flexure; line of attachment for latissimus dorsi slightly marked; lower end of shaft expanding slightly to support the distal trochlea; impression for brachialis anticus rather small, more heavily impressed toward outer margin; ectepicondylar process small, projecting slightly; radial and ulnar trochleae both rather small; entepicondylar process small; external and internal tricipital grooves very lightly marked; olecranal fossa shallow; distal end of entepicondyle (slightly worn) not projecting beyond distal leval of ulnar trochlea; groove between ulnar and radial trochleae broadly open. Bone very light brownish white in color.

Measurements. Total length, 36.1 mm.; greatest breadth across head, 7.1 mm.; transverse breadth of shaft at center, 2.1 mm.; transverse breadth through trochlea, 5.1 mm.

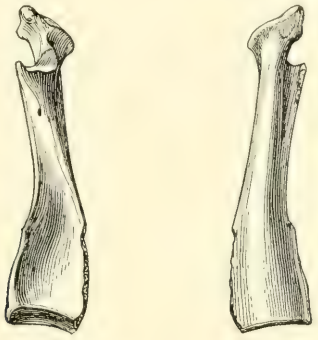
Remarks. While in length the type humerus is similar to the living Virginia rail *Rallus limicola* it is slightly though definitely heavier. The greater length and strength of the crest for the attachment of the large breast muscle is especially evident and would seem to indicate a bird of more active powers of flight. There is, however, a lesser development of the articulations of the lower end of the humerus.

A second humerus, No. 3866, from the left side, with the anterior third more or less missing, was collected at Locality 3 in 1937. This bone so far as it is preserved is in excellent condition and seems somewhat more silicified than the type. It comes from a slightly larger individual as indicated by the following measurements: Transverse breadth of shaft, 2.6 mm.; and transverse breadth across trochleae, 5.3 mm. The size differences are those found between male and female of the modern Virginia Rail, so that it is reasonable to suppose that the type may be from a female individual and that the broken bone from Locality 3 comes from a male.

Comparable measurements of the humerus of the Virginia Rail have been taken from male and female of that bird collected in

Meade county, Kansas, in December, 1942, by Henry Hildebrand for the Museum of Natural History of Kansas University (catalogue numbers 23216 and 23217). These have been loaned to me for study through the courtesy of Charles D. Bunker. The measurements follow, that of the humerus of the male being given first in each instance: Total length, 39.0, 36.1 mm.; greatest breadth across head, 7.0, 6.7 mm.; transverse breadth of shaft at center, 2.2, 2.0 mm.; transverse breadth through trochleae, 5.1, 4.6 mm.

In 1937 a right coracoid, No. 3867, was secured at Locality 2 that obviously refers to *Rallus prenticei* (figs. 13 and 14). The bone has



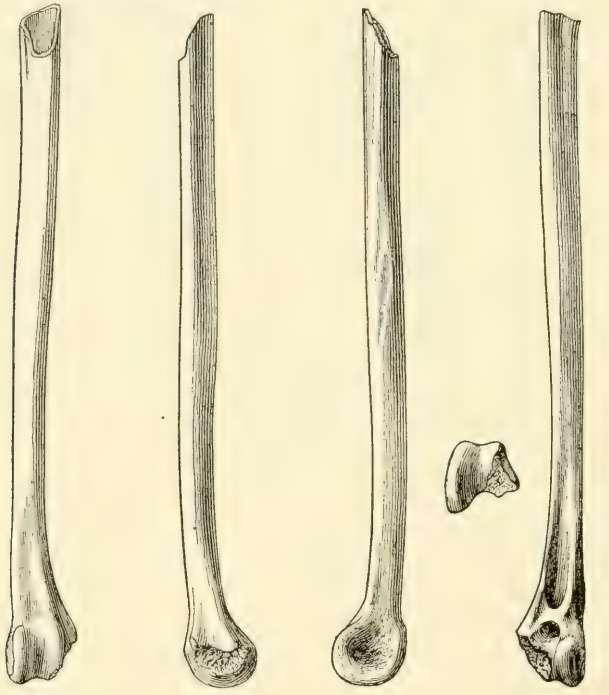
FIGS. 13-14. Right coracoid, Kansas University Museum of Vertebrate Paleontology No. 3867, identified as *Rallus prenticei*, twice natural size.

the outer angle, adjacent to the sternal articulation, and the end of procoracoid missing, but otherwise is complete. Except for definitely larger size it is closely similar to the Virginia Rail. In total length the fossil measures 21.6 mm., while in the largest male Virginia Rail available (U. S. N. M., No. 322701, a bird of unknown locality) this dimension is 18:5 mm. The sternal facet in the fossil is well developed, and the bone as a whole is definitely larger and stronger than in the modern species. A second coracoid from the left side, No. 3868, with the sternal end missing, was obtained in 1937 at Locality 3.

In 1936 the broken distal end of a right tarso-metatarsus, No. 3869, was found at Locality 2. The trochleae are all broken, so that the only note of importance that may be made is the observation that the shaft at its lower end is slightly larger than in the male of the modern Virginia rail.

In the same year of 1936 the distal end of a right tibio-tarsus, No. 3870, was collected at Locality 2, a bone with the condyles somewhat worn so that most of the finer characters are gone. This bone also is definitely heavier than the corresponding one in the male Virginia rail, measuring 2.7 mm. at the smallest transverse diameter of the shaft, this being 2.3 mm. in the largest modern bird. The distal end also is obviously heavier.

The final specimens consist of a right humerus with the head missing, No. 3871, and a left tibio-tarsus (figs. 15 to 19) with the proximal end gone and the distal end considerably broken, No. 3872,



FIGS. 15-19. Left tibio-tarsus, with the proximal end missing, Kansas University Museum of Vertebrate Paleontology No. 3872, identified as *Rallus prenticei,* twice natural size.

that were found in 1936 at Locality 2 lying on top of the dump left by enthusiastic if ill-advised excavations on the part of the young men of the Civilian Conservation Corps who had discovered this deposit of fossil bones. From their exposed situation Doctor Hibbard was not entirely certain that these bones might not be of Recent age. They appear slightly whiter than the majority of the

bones from this place, but there is variation in this regard, some of the undoubted upper Pliocene material being equally white. The humerus has the slightly stockier form with smaller trochleae and slighter ectepicondylar process of *Rallus prenticei*. The tibio-tarsus seems to be from an immature individual that may not have quite attained full growth. The shaft is more slender than the other seen, but the distal end is heavy in spite of the immaturity indicated by the partly developed form of the supra-tendinal bridge. It also is *prenticei*. I believe that there can be no doubt that these two bones belong in the upper Pliocene with the other Rexroad material.

This extinct rail, from consideration of all the bones described, apparently was a bird slightly larger and stockier in build than the living Virginia Rail *Rallus limicola*. Apparently it was common in this locality as its remains are among the most abundant of those preserved.

Fulica americana Gmelin. Coot

The distal end of a left humerus, No. 3994, was collected in 1937 at Locality 3, the bone being in excellent state of preservation. With it there was found a complete left ulna, No. 3988. This species has been recorded widely in the North American Pleistocene from Florida and Texas to Oregon and California, and is here reported for the first time from the Pliocene.

ORDER CHARADRIIFORMES. Shore-birds, Gulls and Auks

FAMILY SCOLOPACIDAE. Snipe, Woodcock and Sandpipers

Scolopacidae, sp. ?

A species of sandpiper of small size is represented by the distal half, more or less, of a right humerus, No. 4488, from Locality 3. The end of the ectepicondylar process is missing, and some of the other processes show wear. The bone is about the size of the humerus in *Pisobia fuscicollis*, and the species may have been one near that group of sandpipers. It does not seem practicable to identify it more definitely at present.

FAMILY LARIDAE. Gulls and Terns

Sterna sp.

In 1937 the party secured a fragmentary left carpo-metacarpus, No. 3989, at Locality 3 that is identified as a tern of the genus

NOTE.—This species is named for Sidney Prentice, now deceased, loyal alumnus of Kansas University, in recognition of his skill and accomplishment in the delineation of vertebrate fossils.

Sterna. The bone lacks much of the head and most of the third metacarpal. It is about the size of the corresponding bone in Forster's Tern *Sterna forsteri*.

ORDER COLUMBIFORMES. Sand-grouse, Pigeons and Doves

FAMILY COLUMBIDAE. Pigeons and Doves

Zenaidura macroura (Linnaeus). Mourning Dove

A left humerus, No. 3995, with the distal end missing, collected at Locality 3 in Meade county in 1937, is typical of the Mourning Dove. While the White-winged Dove *Zenaida asiatica* (listed in the fourth edition of the A. O. U. Check-list published in 1931 under the generic name *Melopelia*) is similar in size, the tuberculum laterale on the posterior dorsal surface of the head is definitely longer and heavier. In the smaller size of this tubercle and in all of its other details the fossil agrees completely with *Zenaidura macroura*.

The mourning dove has been found in Pleistocene deposits in Pinellas county, Florida, and at McKittrick and Rancho La Brea, California, but is here first recorded from the Pliocene. The size of the fossil is that of male examples of the modern bird.

ORDER PSITTACIFORMES. Parrotlike Birds

FAMILY PSITTACIDAE. Lories, Parrots and Macaws

Psittacidae, sp. ?

The proximal end of a left metacarpal from Rexroad Locality 2, collected in 1938, comes from a parrot of medium size. It represents a bird smaller than the Thick-billed Parrot *Rhynchopsitta pachyrhyncha* and larger than the White-fronted Parrot *Amazona albifrons*, but except for this there is not much that may be said about it. The pisiform process is gone, and the specimen is considerably worn otherwise. There is no question but that it represents an unknown species, but the material is too fragmentary to allow proper allocation except to family.

ORDER PASSERIFORMES. Perching Birds

Passeriformes, not identified

The siftings from Localities 2 and 3 of the Rexroad fauna have given us premaxillae, maxillae, humeri and occasional other bones of perching birds, some of them preserved in excellent condition. These have been segregated but after some study for the present are left unnamed. The Order is the most abundant of existing birds as

to species. The great majority are small in size, and many show surprising similarity in form of the bones of the skeleton. It is difficult to identify individual bones of many of the species of the Order that now live in the Plains area of the United States. When to this difficulty we add the further complication of the antiquity found in the Rexroad specimens the situation becomes so involved that at this time I do not care to attempt to identify the species that are represented. There is no question but that several are new to science but to merely name these without being able to assign them to a proper place in relation to the others that are known would only add to our fossil list without contributing in any way to our systematized knowledge. Description should wait for a time until our collections of the modern species, particularly among the vast number found in the region to the south of the United States, are more complete.

In the material at hand there are at least two species, probably more, of Fringillidae, and one Icterid. Others probably include other species of these families and of Compsothlypidae. All appear to belong to the suborder Passeres, and all are of small to medium size.

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SCIENCE BULLETIN

VOL. XXX, pt. I] MAY 15, 1944 [No. 10

Two New Mammals from the Middle Pliocene of Seward County, Kansas

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ABSTRACT: *Osteoborus progressus* sp. nov. and *Pliomastodon adamsi* sp. nov. collected from middle Pliocene deposits along the Cimarron river in Seward county, Kansas, are described.

INTRODUCTION

IN June, 1943, while working with Doctor Thad McLaughlin of the United States Geological Survey, in Seward county, Kansas, we located a new middle Pliocene bone deposit along the Cimarron river. Fragments of vertebrates are common in these beds, but time did not permit any collecting, with the exception of picking up material exposed on the surface. In the small collection made at that time are the remains of two new Pliocene mammals. Invertebrates were also found associated with the vertebrates. There is a possibility that a new "High Plains" fauna can be secured at the locality in the future.

SYSTEMATIC DESCRIPTIONS

Osteoborus progressus sp. nov.

Plate X; figs. 1-4

Holotype. No. 6791, Kansas University Museum of Vertebrate Paleontology. Fragmentary lower jaws, the right half bearing $P_3 - M_3$; the left bearing $P_4 - M_2$.

Horizon and type locality. Ogallala formation, middle Pliocene, Seward county, Locality No. 6, Kansas.

Diagnosis. A large dog nearly as large as *Osteoborus validus* (Matthew and Cook) with a large P_4 approaching the size and

shape of that tooth in *Boroghagus*. The tooth joins M_1 with a square cut contact. The posterior cusp is absent on P_4 and the cingula are greatly reduced. M_1 with reduced metaconid.

Description of holotype. Lower jaws badly crushed at symphysis. Incisors and canines missing with the exception of a broken canine found in the matrix beside the lower jaws. The left jaw is less distorted and contains $P_4 - M_2$ with the alveoli of the other teeth missing. The jaw is deflected outward beneath P_4 and the teeth are set in a slightly curved series. P_4, M_1, and M_2 are well worn. $P_3 - M_3$ are present in the right jaw. The posterior part of the canine alveolus is present, although there is no evidence of P_1 or P_2, probably due to the crushed condition of the jaw. P_3 is set slightly transverse in the jaw. No accessory cusps are present on the tooth. It is unworn and crowded toward M_1 due to the fact that the crown of P_4 had been broken off in life and only the roots remain. M_1 has a reduced metaconid in comparison with the M_1 of *Osteoborus cynoides* (Martin). M_2 worn and rectangular in outline. M_3 much smaller than M_2 and shows but slight wear.

Measurements (in millimeters) of holotype of *Osteoborus progressus*, KUMVP No. 6791 and the holotype of *Osteoborus cynoides* (Martin) KUMVP No. 3468.

	Osteoborus progressus	Osteoborus cynoides
P_3, anteroposterior diameter	9.5	7.8
P_3, greatest transverse diameter	6.5	5.0
P_4, anteroposterior diameter	17.5	14.85
P_4, greatest transverse diameter	12.4	10.5
M_1, anteroposterior diameter	27.8	25.5
M_1, greatest transverse diameter	11.9	11.7
M_1, transverse diameter across heel	10.7	9.5
M_2, anteroposterior diameter	12.0	12.3
M_2, transverse diameter	8.5	8.6
M_3, anteroposterior diameter	6.9	....
M_3, greatest transverse diameter	5.6	....
Depth of ramus between P_2 and P_3	....	24.4
Depth of ramus beneath P_4	39.5	21.3
Depth of ramus beneath M_1	39.1	23.8

Discussion. *Osteoborus progressus* has a much heavier jaw than *O. cynoides*. The development of P_4 separates it from the other known forms of *Osteoborus* in that it is heavily developed, possesses no accessory cusps and the posterior cingula are poorly developed; also P_4 has a square contact with M_1, a character found in *Borophagus*. The presence of the metaconid on M_1 retains the form within the genus *Osteoborus*.

Pliomastodon adamsi sp. nov.

Plate XI

Holotype. No. 6788, Kansas University Museum of Vertebrate Paleontology. Maxillaries containing right and left M^2—M^3.

Horizon and type locality. Ogallala formation, middle Pliocene, Seward county, Locality No. 6, Kansas.

Diagnosis. Largest of the North American *Pliomastodon* known from upper dentition. Upper tusks rounded with no evidence of enamel bands. The external cingulum between the first and the second crests of M^3 forms a well developed tubercle.

Description of holotype. The specimen was badly weathered and eroded. The upper molars are in place in the maxillaries and intact but the amount of warping is not known. The anterior crests of M^2 are separated by a distance of 95.0 mm. The fourth crests of M^3 are separated by a distance of 60.0 mm. M^2 is greatly worn and only the outline of the crests remain. M^3 consists of four well developed crests and a small fifth crest. The first two crests of M^3 are well worn and there is no evidence of a trefoil pattern. The inner cusp of the third crest possesses a poorly developed trefoil. The presence of tubercles between the crests of M^3 are few. The largest developed tubercle is formed from the external cingulum between the first and the second crests. A very small external tubercle is present between the second and the third crests. An internal tubercle is present between the third and the fourth crests and it is the size of that tubercle in *Mammut.*

Four feet of a shattered tusk was associated with the maxillaries. It was round in cross section and there was no evidence of enamel on the surface. The greatest diameter of the tusk was four and one-half inches.

Measurements (in millimeters) of *Pliomastodon*

	P. adamsi Holotype	*P. nevadanus* Holotype	*P. vexillarius* Holotype
M^2, anteroposterior diameter	100.6	112.0	107.0
M^2, transverse diameter across third crest	77.5	71.7	71.0
M^3, anteroposterior diameter	179.0	155.6	158.0
M^3, transverse diameter across first crest	86.0	.....	80.0
M^3, transverse diameter across fourth crest	73.0	.....	71.0

The measurements of *Pliomastodon nevadanus* are after Stock (1936) and those of *P. vexillarius* are after Matthew (1930). *Pliomastodon matthewi* Osborn and *P. cosoensis* Schultz are smaller forms based upon the size of the upper teeth. *Pliomastodon sellardsi* Simpson from the lower Pliocene of Florida is known from the lower jaws and dentition.

The species is named for Messers Horace Adams, A. W. Adams, and Raymond A. Adams who own the XI Ranch and who have cooperated in every way possible to make our work a success in that region.

Discussion. Since the skull and lower jaws of *Pliomastodon adamsi* are unknown, its relationship to the other forms is not known. The genus *Pliomastodon* had a wide geographical range in North America during the Pliocene but it appears to have been less abundant than the other mastodonts whose remains are rather abundant.

The specimen was taken from a gray sandy silt approximately 20 feet above the jaws of *Osteoborus progressus*.

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PLATE X

Osteoborus progressus sp. nov.

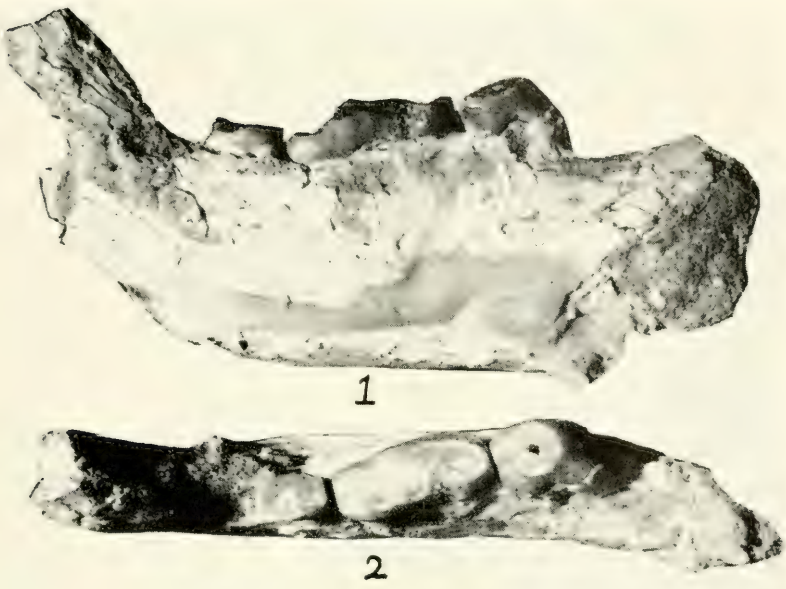
FIG. 1. Holotpye, No. 6791, Kansas University Museum of Vertebrate Paleontology; lingual view of left ramus, P_4—M_2, anteroposterior diameter 58.9 mm.

FIG. 2. Holotype, No. 6791, occlusal view of left ramus, P_4—M_2.

FIG. 3. Holotype, No. 6791, lingual view of right ramus, P_3—M_3.

FIG. 4. Holotype, No. 6791, occlusal view of right ramus, P_3—M_3.

PLATE X



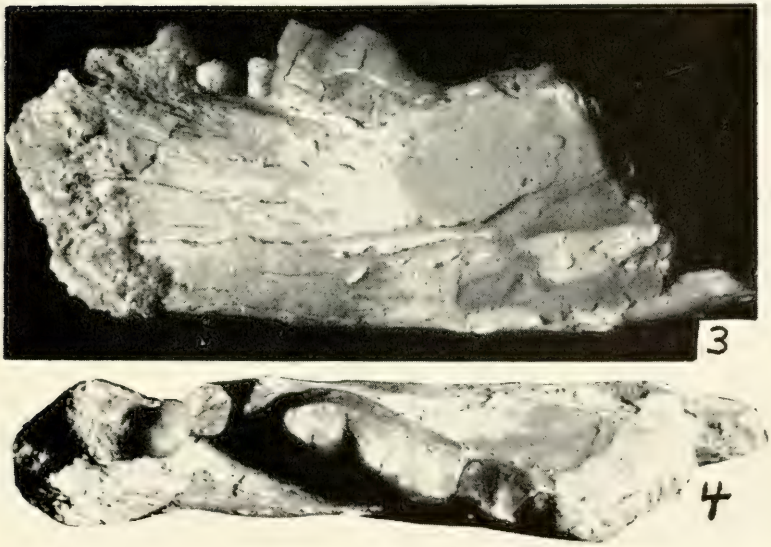


PLATE XI

Pliomastodon adamsi sp. nov.

Holotype, No. 6788, Kansas University Museum of Vertebrate Paleontology; occlusal view, RM^2 and RM^3. Reduced. Anteroposterior diameter 272 mm.

PLATE XI

THE UNIVERSITY OF KANSAS
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VOL. XXX, pt. I] MAY 15, 1944 [No. 11

Present Location of Certain Herpetological and Other Type Specimens

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ABSTRACT: The present location of all the holotype specimens described by Edward H. Taylor is given, with their present museum numbers. A list is appended of all other type specimens in the Edward H. Taylor-Hobart M. Smith Collection (EHT-HMS).

INDEX

PAGE
Species described by Edward H. Taylor 119
Amphibia 119
Gymnophiona 119
Caudata 119
Salientia 125
Reptilia 143
Lacertilia 143
Serpentes 152
Testudinata 160
Mammalia 161
Bibliography 164
List of other type specimens in the EHT-HMS collections 174
Amphibia 175
Caudata 175
Salientia 176
Reptilia 179
Lacertilia 179
Serpentes 184

INTRODUCTION

BECAUSE of numerous inquiries as to the present whereabouts of certain type specimens described by me, and because of a specific suggestion from Mr. Graham Netting, Curator of Herpetology at Carnegie Museum that such a publication was desirable, I have prepared the following list. It purports to give the present location of all holotype specimens described by me alone or under joint authorship, and their present location and, when known, their present museum numbers. For convenience the type locality and publication has been included. Owing to the fact that the date of publication (mailing date) of many of the papers containing type descriptions, differs one to two years from the printed date on the publication, I have appended a complete bibliography with dates of publication authenticated as nearly as possible. While most of the descriptions deal with herpetological species, one monograph describes several new mammals. These forms, too, are appended to the list for the sake of completeness.

It is impossible to learn the fate of collections in the Philippine Islands (Nov., 1943). Queries made in 1941 as to changes in numbers, if any, were unanswered. Whether or not the types herein listed have survived the bombing of Manila awaits to be ascertained.

I am aware of the desirability of having included the present taxonomic status of each species, inasmuch as certain ones have been referred to synonymy or placed in different genera. In many cases the changed status is recorded, where I have synonymized the form or where the reference seemed to have been based on reasonable judgment and an opportunity to examine a proper material. In other cases where the reference has seemed unwarranted, that is, based on material other than typical, or due to a different understanding of taxonomic categories, or where I have been unable to verify the reason for the action, no change or comment has been made. Certain literature references containing proposed changes may have been overlooked.

AMPHIBIA

GYMNOPHIONA

ICHTHYOPHIS GLANDULOSUS Taylor. Holotype.

Type. Cal. Acad. Sci., No. 60073. Originally EHT, No. 1595A.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 516-517, pl. 3, figs. 4. 5.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.,* E. H. Taylor, Oct. 23, 1921.

ICHTHYOPHIS WEBERI Taylor. Holotype.

Type. Bureau of Science, No. B 1.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 227-228.

Type loc. Malagan River, Palawan, P. I. *Coll.,* C. M. Weber, Jan. 28, 1909.

CAUDATA

AMBYSTOMA AMBLYCEPHALA Taylor. Holotype.

Type. EHT-HMS, No. 16443. *Paratypes.* EHT-HMS, Nos. 16442, 16444, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 420-21, pl. XLV, fig. 2.

Type loc. Fifteen km. W. of Morelia [Tacícuaro], Michoacán, México. *Coll.,* E. H. Taylor, Sept. 10, 1938.

AMBYSTOMA BOMBYPELLA Taylor. Holotype.

Type. EHT-HMS, No. 3997. *Paratypes.* EHT-HMS, Nos. 3998, topotype; 18896, 15 km. W. Morelia, Michoacán.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 318-320, pl. XLV, fig. 1.

Type loc. Rancho Guadelupe, 14 km. E of San Martín (Asunción), México, México. *Coll.,* E. H. Taylor, Aug. 4, 1932.

AMBYSTOMA FLUVINATUM Taylor. Holotype.

Type. EHT-HMS, No. 25383. Paratypes. EHT-HMS, Nos. 25384-25395, all topotypes.

Publ. Copeia, 1941, No. 3, Sept. 30, pp. 144-146, fig. 2, A. B.

Type loc. Mojárachic, Chihuahua, México. *Coll.,* Irving Knobloch, June 20, 1940.

AMBYSTOMA GRANULOSA Taylor. Holotype.

Type. EHT-HMS, No. 29805. *Paratypes.* EHT-HMS, Nos. 29804, 24042-24044, 24045-24250, 10-12 mi. N.W. Toluca, México.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 5, May 15, 1944, pp. 57-61, pl. VIII.

Type loc. (Km. 74) about 12 mi. N.W. of Toluca, México, México. *Colls.,* E. H. Taylor and Hobart M. Smith, Sept. 10, 1939.

AMBYSTOMA LACUSTRIS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 6274 (Field No.), *Paratypes.* EHT-HMS, Nos. 22894-22910, topotypes.

Publ. *See entry* 1944h, p. 174.

Type loc. Lake Zumpango, México, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Mar. 3, 1939.

AMBYSTOMA ORDINARIA Taylor. Holotype.

Type. EHT-HMS, No. 16367. *Paratypes.* EHT-HMS, Nos. 16364-16366, 16367A, 16368-16370, 16372-16382, 16384-16386, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 422-424, pl. XLVI, figs. 1-3.

Type loc. About 9,000 ft. elev. near Puerto Hondo (4 mi. W. of El Mirador), Michoacán, México. *Coll.*, E. H. Taylor, Sept. 2, 1938.

AMBYSTOMA ROSACEUM Taylor. Holotype.

Type. EHT-HMS, No. 23054. *Paratypes.* EHT-HMS, Nos. 23055-23058, all topotypes.

Publ. Copeia, 1941, No. 3, Sept. 30, pp. 143-144, fig. 1, A, B.

Type loc. Mojárachic, Chihuahua, México. *Coll.*, Irving Knobloch, June, 1939.

AMBYSTOMA SCHMIDTI Taylor. Holotype.

Type. EHT-HMS, No. 3999.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939, 1st mailing), pp. 263-264, pl. XXVI, fig. 1.

Type loc. Ten mi. E. of San Martín (Asunción) at Rancho Guadalupe, México, México. *Coll.*, E. H. Taylor, Aug. 3, 1932.

AMBYSTOMA SUBSALSUM Taylor. Holotype.

Type. EHT-HMS, No. 22139. *Paratypes.* EHT-HMS, Nos. 28357-28390, all topotypes.

Publ. Copeia, 1943, No. 3, Oct. 15, pp. 151-156, figs. 1-3.

Type loc. Lake Alchichica, Puebla, México. *Coll.*, Dyfrig McH. Forbes, 1940.

*BATRACHOSAUROIDES DISSIMULANS Taylor and Hesse. Holotype.

Type. A. & M. College, Texas, Mus. No. 2234.

Publ. Amer. Journ. Sci. Vol. 241, Mar., 1943, pp. 185-193, fig. 1.

Type loc. Middle Miocene, 3 mi. N.W. Cold Springs, San Jacinto County, Texas, U. S. A. *Coll.*, Mrs. Claude Riley, Mar., 1938.

BOLITOGLOSSA ARBOREA Taylor. Holotype.

Type. EHT-HMS, No. 16743. *Paratypes.* EHT-HMS, Nos. 16734-16742, 16744-16756, topotypes.

Publ. Herpetologica, Vol. 2, No. 3, Mar. 25, 1941, pp. 62-65, text figs. 4, 5.

Type loc. Near Tianguistengo, Hidalgo, México. *Coll.*, E. H. Taylor, Aug. 15, 1939.

BOLITOGLOSSA CHONDROSTEGA Taylor. Holotype.

Type. EHT-HMS, No. 17304. *Paratypes.* EHT-HMS, Nos. 17282-17303, 17305-17310, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, Dec. 15, 1941, pp. 113-115.

Type loc. Durango, Hidalgo, México, 5,000-6,000 ft. *Coll.*, E. H. Taylor, Sept. 12, 1938.

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* Starred forms are described from fossil remains.

BOLITOGLOSSA COCHRANAE Taylor. Holotype.

Type. EHT-HMS, No. 24594. *Paratypes.* EHT-HMS, Nos. 17726-17727, 24589-24593, 24595-24599, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 343-345.

Type loc. Cerro San Felipe, Oaxaca, Oaxaca, México. *Colls.,* Richard C. Taylor and E. H. Taylor.

BOLITOGLOSSA DIMIDIATA Taylor. Holotype.

Type. EHT-HMS, No. 17677. *Paratypes.* EHT-HMS, Nos. 17671-17676, 17678-17689, 17691-17692, 17694-17705, topotypes, and El Chico Nat. Park, Hidalgo.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 408-411, text figs. 1, 2.

Type loc. Guerrero, near Mineral del Monte, Hidalgo, México. *Coll.,* E. H. Taylor, Aug. 8, 1938.

BOLITOGLOSSA GALEANAE Taylor. Holotype.

Type. EHT-HMS, No. 17146. *Paratypes.* EHT-HMS, Nos. 17145, 25762-25763, topotypes.

Publ. Proc. Biol. Soc., Washington, Vol. 54, July 31, 1941, pp. 83-85.

Type loc. Near Galeana, Nuevo León, México (7,000 ft. elev.). *Coll.,* Radclyffe Roberts, July 10, 1938.

[The original spelling "galaenae" is a typographical error.]

BOLITOGLOSSA LAVAE Taylor. Holotype.

Type. EHT-HMS, No. 28937. *Paratypes.* EHT-HMS, Nos. 28930-28936, 28938-29064, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 295-298, pl. 27, figs. 5-6.

Type loc. Two mi. W. La Joya, Veracruz, México. *Colls.,* E. H. Taylor, Aug. 16, 1941.

BOLITOGLOSSA MELANOMOLGA Taylor. Holotype.

Type. EHT-HMS, No. 24626.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 81-83.

Type loc. Twenty km. N. of San Antonio Limón (Totalco), Veracruz, México. *Coll.,* E. H. Taylor, June 24, 1940.

BOLITOGLOSSA NIGROFLAVESCENS Taylor. Holotype.

Type. U. S. Nat. Mus. No. 111169. *Paratypes.* EHT-HMS, Nos. 26784-26799, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, Dec. 15, 1941, pp. 150-152, pl. VIII; pl. IX, figs. 9-10.

Type loc. Cerro Ovando, 5,000-6,000 ft., Chiapas, México. *Colls.,* Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

BOLITOGLOSSA NIGROMACULATA Taylor. Holotype.

Type. U. S. Nat. Mus., No. 110635. *Paratypes.* EHT-HMS, Nos. 24600-24621, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, Dec. 15, 1941, pp. 141-145.

Type loc. Cuautlapan, Veracruz. *Coll.,* Hobart M. Smith.

BOLITOGLOSSA OCCIDENTALIS Taylor. Holotype.

Type. U. S. Nat. Mus., No. 111085. *Paratypes.* EHT-HMS, Nos. 27176-27180, topotypes; 24049, Finca Juarez, Chiapas; 26561, El Porvenir, Guatemala [exc. Field Mus.].

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, 1941 (Dec.), pp. 145-147, text fig. 1, C.

Type loc. La Esperanza [near Escuintla], Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 28, 1940.

BOLITOGLOSSA TERRESTRIS Taylor. Holotype.

Type. EHT-HMS, No. 23354. *Paratypes.* EHT-HMS, Nos. 17311-17359, 23244-23310, topotypes; 23311-23405.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 115-117.

Type loc. Six mi. S. Tianguistengo, Hidalgo, México (elev. 5,000 ft.). *Coll.*, E. H. Taylor, July 1, 1940.

BOLITOGLOSSA UNGUIDENTIS Taylor. Holotype.

Type. EHT-HMS, No. 17102. *Paratypes.* EHT-HMS, Nos. 17103-17113, 17115, 17116, 15630, 15642, 15643, 16547A, 15649A, 15651, topotypes.

Publ. Herpetologica, Vol. 2, No. 3, Mar. 25, 1941, pp. 57-62, text figs. 1-3.

Type loc. Cerro San Felipe, 15 km. N. of Oaxaca, Oaxaca, México. *Coll.*, E. H. Taylor, Aug. 20, 1938.

BOLITOGLOSSA XOLOCALCAE Taylor. Holotype.

Type. U. S. Nat. Mus., No. 111371. *Paratypes.* EHT-HMS, Nos. 25311-25341, 26749-26783, 27264-27271, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, 1941 (Dec.), pp. 148-150, pl. VII, pl. IX, figs. 7-8.

Type loc. Cerro Ovando, between 6,000-8,000 ft., Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

*LANEBATRACHUS MARTINI Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1468.

Publ. Geol. Surv. Kansas, 1941, Report of Studies, Bull. 38, pt. 6, July 7, 1941, pp. 180-181, fig. 4, A, B.

Type loc. Edson Beds, Ogallala formation, Middle Pliocene, Sherman county, Kansas. *Coll.*, H. T. Martin.

OEDIPUS ALTAMONTANUS Taylor. Holotype.

Type. EHT-HMS, No. 12245. *Paratype.* EHT-HMS, No. 12239, topotype.

Pub. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 272-274, pl. XXV, figs. 3, 4.

Type loc. Lake Zempoala (Cempoala), Morelos, México (elev. 10,500 ft.). *Coll.*, E. H. Taylor, Aug. 6, 1936.

OEDIPUS GIGANTEUS Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 8435. *Paratypes.* EHT-HMS, Nos. 12040, 12085, Cofre de Perote, Veracruz. [Other paratypes 8434, 8436, 8437 in Harvard Coll. Mus. Comp. Zoöl.]

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 266-269, pl. XXVII, figs. 3, 4.

Type loc. Jalapa, Veracruz, México. *Coll.*, E. R. Dunn.

OEDIPUS MANNI Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 3915. *Paratypes.* EHT-HMS, Nos. 15656-15657.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 277-280, pl. XXIX, figs. 4-6.

Type loc. Guerrero, Hidalgo, México. *Coll.,* W. M. Mann.

OEDIPUS MULTIDENTATA Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 14812. *Paratypes.* EHT-HMS, Nos. 15658-15848, El Chico, Hidalgo.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 289-291, pl. XXIX, fig. 1.

Type loc. Alvarez (km. 53 on the Potosí and Rio Verde R.R.), San Luis Potosí, México, elev. 8,000 ft. *Coll.,* W. W. Brown.

OEDIPUS ROBERTSI Taylor. Holotype

Type. EHT-HMS, No. 12503. *Paratypes.* EHT-HMS, Nos. 12496-12498, 12504-12505, 15600-15615, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 287-289, pl. XXVI, fig. 2.

Type loc. Nevada de Toluca (elev. 10,000-11,000 ft.), México, México. *Coll.,* H. Radclyffe Roberts, Sept. 7, 1936.

OEDIPUS SMITHI Taylor. Holotype.

Type. EHT-HMS, No. 3966. Paratypes. EHT-HMS, Nos. 3965-3969, 15616-15641, topotypes. [Cerro San Luis is a spur of Cerro San Felipe (Mts.) near Oaxaca.]

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 269-272, pl. XXV, figs. 5, 6.

Type loc. Cerro San Luis, 15 mi. N.W. Oaxaca, Oaxaca, México. *Coll.,* H. M. Smith, Aug. 5, 1935.

*OGALLALABATRACHUS HORARIUM Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1470.

Publ. Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 6, July 7, 1941, pp. 181-182, figs. 7a-c.

Type loc. Ogallala formation, Middle Pliocene (Rhinoceros Hill), Wallace county, Kansas. *Colls.,* David Dunkle and E. H. Taylor.

PLETHODON HARDII Taylor. Holotype.

Type. EHT-HMS, No. 23656.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 78-80.

Type loc. Sacramento Mountains, 9,000 ft., at Cloudcroft, New México. *Coll.,* D. E. Hardy, June 29, 1940.

PSEUDOEURYCEA CEPHALICA RUBRIMEMBRIS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 110661. *Paratypes.* EHT-HMS, Nos. 12495, Minas, Viejas, Hidalgo; 23007, topotype; 29831, Zacualtipan, Hidalgo.

Publ. See entry 1944h, p. 174.

Type loc. Six km. S. Santa Anita, Hidalgo, elev. about 4,500 ft. *Colls.,* Dr. and Mrs. Hobart M. Smith

RHYACOSIREDON LEORAE Taylor. Holotype.

Type. EHT-HMS, No. 22560. *Paratypes.* EHT-HMS, No. 22561, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. 2, No. 8, 1943 (Oct. 15), pp. 345-347, pl. XXVI, fig. 3.

Type loc. In a mountain stream near Río Frío, México, either in the state of Puebla or México. *Coll.,* Dyfrig McHattie Forbes, 1939.

RHYACOSIREDON RIVULARIS Taylor. Holotype.

Type. EHT-HMS, No. 16388. *Paratypes.* EHT-HMS, Nos. 16387, 16389-16393, all topotypes.

Publ. Herpetologica, Vol. 1, 1940, pp. 171-176, pl. XVII.

Type loc. Thirteen km. W. Villa Victoria, México, México. *Coll.,* E. H. Taylor, Sept. 11, 1938.

RHYACOSIREDON ZEMPOALAENSIS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 116617. *Paratypes.* EHT-HMS, Nos. 22172-22190, 24630-24634, topotypes.

Publ. See entry 1944h, p. 174.

Type loc. Lakes of Zempoala, Morelos, México, in a nearly dry lake bed, 10,000 ft. elevation. *Coll.,* Hobart M. Smith.

SIREDON LERMAENSIS Taylor. Holotype.

Type. EHT-HMS, No. 22578. *Paratypes.* EHT-HMS, Nos. 22586, 15436-15440, 22571-22586, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 427-430.

Type loc. Lake Lerma, E. of Toluca, México, México. *Colls.,* E. H. Taylor and H. M. Smith—purchased from fisherman—Sept. 16, 1939.

THORIUS DUBITUS Taylor. Holotype.

Type. EHT-HMS, No. 17751. *Paratypes.* EHT-HMS, Nos. 17731-17750, 17752-17786, 22064-22084, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 107, 108-110, pl. III, fig. 3.

Type loc. Two mi. S. of Acultzingo, Veracruz, México, at summit of mountains. *Coll.,* E. H. Taylor, July 20, 1938.

THORIUS NARISOVALIS Taylor. Holotype.

Type. EHT-HMS, No. 17859. *Paratypes.* EHT-HMS, Nos. 17794-17858, 17860-17870, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 416-418, pl. XLVII, fig. 3.

Type loc. Elevation 2,600-3,000 M. on Cerro San Felipe, 15 km. N. of Oaxaca, Oaxaca, México. *Coll.,* E. H. Taylor, Aug. 18-22, 1938.

THORIUS PULMONARIS Taylor. Holotype.

Type. EHT-HMS, No. 16684. *Paratypes.* EHT-HMS, Nos. 16676-16683, 16685-16711, 16713-16733, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 411, 414, text figs. 3, 4.

Type loc. Cerro San Felipe about 12 km. N. of Oaxaca, Oaxaca, México. *Coll.,* E. H. Taylor, Aug. 18, 1938.

THORIUS TROGLODYTES Taylor. Holotype.

Type. EHT-HMS, No. 17791. *Paratypes.* EHT-HMS, Nos. 12142-12143, 17789-17790, 17791A, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 110-112, pl. III, fig. 4.

Type loc. Two mi. S. Acultzingo, Veracruz, Mexico. *Coll.,* E. H. Taylor, July 10, 1938.

SALIENTIA

ACRODYTES INFLATUS Taylor. Holotype.

Type. EHT-HMS, No. 17890. *Paratypes.* EHT-HMS, Nos. 17889, 17891, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 6, 1943, pp. 64-67, pl. IX.

Type loc. Near La Venta, Guerrero, México. *Coll.,* E. H. Taylor, June 27, 1938.

ACRODYTES MODESTUS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 115013.

Publ. See entry 1944h, p. 174.

Type loc. Cruz de Piedra, near Acacoyagua, Chiapas, México. *Colls.,* Dr. and Mrs. Hobart M. Smith.

*ANCHYLORANA DUBITA Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6377.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 209-211, pl. XV, figs. 4A-4B.

Type loc. Rexroad Member, Upper Pliocene, loc. 3, about 16 mi. S. W. of Meade, Meade County, Kansas. *Coll.,* Claude W. Hibbard & party, 1938.

*ANCHYLORANA MOOREI Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6375.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 211-212, pl. XV, fig. 3A, 3B.

Type loc. Rexroad Member, Upper Pliocene, loc. 3, 16 Mi. S. W. Meade, Meade County, Kansas. *Coll.,* Claude W. Hibbard and party, 1939.

*ANCHYLORANA ROBUSTOCONDYLA Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5106.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 211-212, pl. XV, fig. 1.

Type loc. Rexroad Member, Upper Pliocene, loc. 3, 16 mi. S. W. of Meade, Meade County, Kansas. *Coll.,* Claude W. Hibbard and party, 1937.

BARBOURULA BUSUANGENSIS Taylor and Noble. Holotype.

Type. Mus. Comp. Zoöl. Harvard College, No. 14004. Originally EHT, No. 539.

Publ. Amer. Mus. Nov., No. 121, June 23, 1924, pp. 1-4, fig. 1.

Type loc. Busuanga I., Calamian Islands, P. I. *Coll.,* E. H. Taylor, Sept. 16, 1923.

BUFO ANGUSTIPES Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 116513.

Publ. *See entry* 1944h, p. 174.

Type loc. La Esperanza (near Escuintla) Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 7, 1940.

*BUFO ARENARIUS Taylor. Holotype.

Type. Kansas Univ. Mus. Vert. Paleontology, No. 1452.

Publ. Anal. Inst. Biol., (México), Tom. 7, No. 4, 1936, pp. 521-523; Lám. 1, figs. 2, 10-14; Lám. 2, figs. 1-2, 6, 7, 9-12.

Type loc. Edson Beds, Ogallala, Middle Pliocene, Sherman County, Kansas. *Colls.*, H. T. Martin and Claude Hibbard, 1929.

BUFO GEMMIFER Taylor. Holotype.

Type. EHT-HMS, No. 18509. *Paratypes.* EHT-HMS, Nos. 18497-18508, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 490-492, pl. LIII, figs. 3, 3a, 3b.

Type loc. El Limoncito, near La Venta, Guerrero, México. *Coll.*, E. H. Taylor, June 29, 1938.

*BUFO HIBBARDI Taylor. Holotype.

Type. Kansas Univ. Mus. Vert. Paleo., No. 1437.

Publ. Anal. Inst. Biol. (México), Tom. 7, No. 4, 1936, pp. 517-521, Lám. I, figs. 3-9; Lám. II, figs. 3-4, 13-14.

Type loc. Edson Beds, Ogallala formation, Middle Pliocene, Sherman County, Kansas. *Coll.*, Claude Hibbard, 1929.

BUFO KELLOGGI Taylor. Holotype.

Type. EHT-HMS, No. 21. *Paratypes.* EHT-HMS, Nos. 15-20, 22-40, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXIV, No. 20, 1936 (Feb. 15, 1938), pp. 510-514, pl. XLV, figs. 1-3.

Type loc. Two mi. E. of Mazatlán, Sinaloa, México. *Coll.*, E. H. Taylor, July 21, 1934.

BUFO MAZATLANENSIS Taylor. Holotype.

Type. EHT-HMS, No. 374. *Paratypes.* EHT-HMS, Nos. 373, 375-379, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 492-494, pl. LIII, fig. 1, pl. LIV.

Type loc. Two mi. E. Mazatlán, Sinaloa, México. *Coll.*, E. H. Taylor, July 20, 1934.

BUFO MCGREGORI Taylor. Holotype.

Type. California Academy of Sciences, No. 61839. Originally EHT, No. 1468A. *Paratypes.* M. C. Z. 14532-14538.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 182-184, pl. 4, figs. 2-3.

Type loc. Near Pasananka, Zamboanga Prov., Mindanao, P. I. *Coll.*, E. H. Taylor, Sept. 30, 1920.

BUFO NAYARITENSIS Taylor. Holotype.

Type. EHT-HMS, No. 397. *Paratypes.* EHT-HMS, Nos. 380-396, 398-426, 426A, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 14, 1943, pp. 349-351, pl. XXVI, figs. 1, 1a.

Type loc. Tepic, Nayarit, México. *Coll.,* E. H. Taylor, July 28, 1934.

BUFO PERPLEXUS Taylor. Holotype.

Type. EHT-HMS, No. 707. *Paratypes.* EHT-HMS, Nos. 682-683, 684-706, 708, 709, 708A, 813-818, 820-828, 6209-6234, 6236-6266, 6267-6271, 6273-6274, 6276, 18213-18224, 18441, 25419-25422, various localities.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 347-349, pl. XXVI, figs. 1b, 2.

Type loc. Near the edge of the Balsas river near Mexcala, Guerrero, México. *Coll.,* Hobart M. Smith and E. H. Taylor, June 24, 1932.

CENTROLENELLA VIRIDISSIMA Taylor. Holotype.

Type. EHT-HMS, No. 27725. *Paratypes.* EHT-HMS, Nos. 27719-27724, 27726, 27727, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, May 15, 1942, pp. 75-77, pl. IX, figs. 2, 2a, 2b.

Type loc. Agua del Obispo, Guerrero, México. *Coll.,* E. H. Taylor, Aug. 2, 1941.

CHAPERINA BEYERI Taylor = *Sphenophryne fusca* Mocquard. Holotype.

Type. Carnegie Museum, No. 3312. Originally EHT, No. 557 (Field No. 414).

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 333-335, pl. 3, fig. 3.

Type loc. Near Upper Agusan [river]; between the Agusan and Simulao rivers, probably in Davao Prov., or Agusan near the Davao-Agusan boundary. *Coll.,* E. H. Taylor, June, 1913.

CHAPERINA VISAYA Taylor. Holotype.

Type. Bureau of Science, No. B 80.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 335-336, pl. 9, fig. 3.

Type loc. Biliran I., near Leyte, P. I. *Coll.,* Richard C. McGregor, May, 1914.

CORNUFER CORNUTUS Taylor. Holotype.

Type. California Academy of Sciences, No. 61476. Originally EHT, No. 764.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 175-176.

Type loc. Balbalan, Kalinga, Luzon, P. I. *Coll.,* E. H. Taylor, Apr. 24, 1920.

CORNUFER LATICEPS Taylor. Holotype.

Type. Carnegie Museum, No. 3496. Originally EHT, No. 197.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 317-318, pl. 3, fig. 1.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Sept., 1912.

CORNUFER MONTANUS Taylor. Holotype.

Type. California Academy of Sciences, No. 61179. Originally EHT, No. 861.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 272-273, pl. 4, fig. 4.

Type loc. Mt. Banajao (1,500 M. elev.), Laguna Prov., Luzon, P. I. *Coll.,* E. H. Taylor, May 31, 1920.

CORNUFER RIVULARIS Taylor. Holotype.

Type. California Academy of Sciences, No. 61179. Originally EHT, No. 761. *Paratype.* EHT-HMS No. 29875, topotype.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 270-272, pl. 4, fig. 3.

Type loc. Balbalin, Kalinga subprov., Luzon, P. I. *Coll.,* E. H. Taylor, Apr. 25, 1920.

CORNUFER SUBTERRESTRIS Taylor. Holotype.

Type. California Academy of Sciences, No. 61518. Originally EHT, No. 707.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 274-275.

Type loc. Km. 101 on Mountain Trail, Mountain Prov., Luzon, P. I. *Coll.,* E. H. Taylor, Apr. 17, 1920.

DIAGLENA RETICULATA Taylor. Holotype.

Type. U.S. Nat. Mus., No. 115500.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 4, May 15, 1942, pp. 60-62, pl. IV, figs. 2, 2a, 2b; pl. V, fig. 1.

Type loc. Cerro Arenal, Oaxaca, México. *Coll.,* Thomas MacDougall, Jan. 2, 1940.

ELEUTHERODACTYLUS AVOCALIS Taylor and Smith. Holotype.

Type. U.S.N.M., No. 116885.

Publ. *See entry* 1944h, p. 174.

Type loc. Tres Cruces, near Tehuantepec, Oaxaca, México. *Colls.,* Dr. and Mrs. Hobart M. Smith, Mar., 1940.

ELEUTHERODACTYLUS BATRACHYLUS Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard College, No. 9308.

Publ. Proc. New England Zoöl. Club, Vol. XVIII, Jan. 24, 1940, pp. 13-16, pls. I, II.

Type loc. Miquihuana, Tamaulipas, 80 mi. S.W. of [Cuidad] Victoria, Tamaulipas, México. *Coll.,* W. W. Brown, 1922.

ELEUTHERODACTYLUS BOLIVARI Taylor. Holotype.

Type. EHT-HMS, No. 29564.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 298-299, pl. 26, figs. 1-4.

Type loc. Ixtapan del Oro, México, *Coll.,* C. Bolivar Pieltain, June 11, 1940.

ELEUTHERODACTYLUS CACTORUM Taylor. Holotype.

Type. EHT-HMS, No. 6383. *Paratypes.* EHT-HMS, Nos. 6376, 6382, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 391-394, text fig. 2.

Type loc. Km. 226, 20 mi. N.W. of Tehuacán, Puebla [near Cacaloapam], México. *Coll.,* E. H. Taylor, Aug. 30, 1936.

ELEUTHERODACTYLUS CONSPICUUS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 116509. *Paratype.* EHT-HMS, No. 29807, topotype.

Publ. *See entry* 1944h, p. 174.

Type loc. Piedras Negras, Guatemala, practically on México-Guatemala border. *Colls.*, Dr. and Mrs. Hobart M. Smith, May 29, 1939.

ELEUTHERODACTYLUS DECORATUS Taylor. Holotype.

Type. EHT-HMS, No. 28720. *Paratype.* EHT-HMS, No. 28719, 2 mi. W. La Joya, Veracruz.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 301-304, pl. 25, figs. 1-4; pl. 27, fig. A.

Type loc. Near Banderia, 6 mi. W. Jalapa, Veracruz, México. *Coll.*, E. H. Taylor, Aug. 16, 1941.

ELEUTHERODACTYLUS DORSOCONCOLOR Taylor. Holotype.

Type. U. S. Nat. Mus., No. 110610. *Paratype.* EHT-HMS, No. 24321.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 8, Dec., 1941, pp. 152-154, pl. X.

Type loc. Tequeyutepec, Veracruz, México. *Coll.*, Hobart M. Smith.

ELEUTHERODACTYLUS HIDALGOENSIS Taylor. Holotype.

Type. EHT-HMS, No. 24454. *Paratype.* EHT-HMS, No. 24455, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 299-301, pls. 25, figs. 5-8; 27, fig. 10.

Type loc. Four mi. N. of Tianguistengo, Hidalgo, México.

ELEUTHERODACTYLUS HOBARTSMITHI Taylor = *Microbatrachylus hobartsmithi* (Taylor), genotype of *Microbatrachylus* Taylor. Holotype.

Type. EHT-HMS, No. 2688. *Paratypes.* EHT-HMS, Nos. 3686, 3687, topotypes.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (July 2, 1937), pp. 355-357, pl. 1, figs. 5-6.

Type loc. Near Uruapan, Michoacán, México. *Coll.*, Hobart M. Smith, July 19, 1935.

ELEUTHERODACTYLUS MACDOUGALLI Taylor. Holotype.

Type. EHT-HMS, No. 27482.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. I, No. 5, May 15, 1942, pp. 71-73, pl. VII.

Type loc. La Gloria, Oaxaca, México (N. of Niltepec, elev. 4,500 ft.). *Coll.*, Thomas MacDougall.

ELEUTHERODACTYLUS MATUDAI Taylor. Holotype.

Type. U. S. Nat. Mus., No. 110626. *Paratypes.* EHT-HMS, Nos. 24353-24354, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 5, Dec., 1941, pp. 154-157, pl. XI.

Type loc. Mt. Ovando, Chiapas, México. *Colls.*, Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

ELEUTHERODACTYLUS NATATOR Taylor. Holotype.

Type. EHT-HMS, No. 6373. *Paratypes.* EHT-HMS, Nos. 6371, 6372, 6374, 6375, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 394-397, pl. XXXIX, fig. 2; pl. XL.

Type loc. Tlilapam [=Cuautlapan], Veracruz, México. *Coll.,* E. H. Taylor, Aug. 16, 1936.

ELEUTHERODACTYLUS OCCIDENTALIS Taylor. Holotype.

[*Novum nomen.* = *Borborocoetes mexicanus* Boulenger, preoccupied by *Leuiperus* (sic) *mexicanus* = *Eleutherodactylus mexicanus* (Brocchi)].

Type. (Cotypes.) Brit. Mus. Nat. Hist., Nos. 92.2.8.66-67.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 91-92.

Type loc. Hacienda el Florencio, Zacatecas. *Coll.,* A. C. Buller.

ELEUTHERODACTYLUS PGYMAEUS Taylor [= *Microbatrachylus pygmaeus* (Taylor)]. Holotype.

Type. EHT-HMS, No. 3691.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (July 2, 1937), pp. 352-354.

Type loc. One mile N. Rodriguez Clara, Veracruz. *Colls.,* E. H. Taylor and Hobart M. Smith, Sept. 7, 1935.

ELEUTHERODACTYLUS SALTATOR Taylor. Holotype.

Type. EHT-HMS, No. 24301. *Paratypes.* EHT-HMS, Nos. 24293, 24298, 24299, topotypes.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 89-91.

Type loc. Omilteme, Guerrero, México. *Coll.,* E. H. Taylor, Aug. 2, 1940.

ELEUTHERODACTYLUS TARAHUMARAENSIS Taylor. Holotype.

Type. EHT-HMS, No. 23008.

Publ. Copeia, 1940, No. 4, Dec. 27, pp. 250-253, fig. 1.

Type loc. Mojárachic, Chihuahua, México, elev. 6,900 ft., Tarahumara Mts. *Coll.,* Irving W. Knobloch, 1939.

ELEUTHERODACTYLUS VOCALIS Taylor. Holotype.

Type. EHT-HMS, No. 5390. *Paratypes.* EHT-HMS, Nos. 6384-6389, 6391, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 401-405, pl. LXIV; text fig. 8.

Type loc. Hda. El Sabino, Uruapan, Michoacán, México. *Coll.,* Hobart M. Smith, July 25, 1936.

HAZELIA SPINOSA Taylor. Holotype & Genotype.

Type. Carnegie Museum, No. 3420. Originally EHT, No. 406.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 292-295, pl. 7, fig. 1.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Aug., 1912.

HYLA ARBORESCANDENS Taylor. Holotype.

Type. EHT-HMS, No. 3135 ♂.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 388-391, text fig. 1.

Type loc. Three km. S. W. Acultzingo, Veracruz, México. *Colls.,* E. H. Taylor and Hobart M. Smith, July 22, 1932.

HYLA ARBORICOLA Taylor. Holotype.

Type. EHT-HMS, No. 24556. *Paratypes.* EHT-HMS, Nos. 24557-24588, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 118-119, pl. V, fig. 1.

Type loc. Elevation, about 7,000 ft., 6 mi. E. of Omilteme, Guerrero, México. *Coll.,* E. H. Taylor, Aug. 5, 1942.

HYLA BELTRANI Taylor. Holotype.

Type. EHT-HMS, No. 29563.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 306-308, pl. 26, figs. 5-8.

Type loc. Tapachula, Chiapas, México. *Coll.,* A. Magaña, Aug. 1, 1941.

HYLA BROMELIANA Taylor. Holotype.

Type. EHT-HMS, No. 16630. *Paratypes.* EHT-HMS, Nos. 16628, 16629, 16631, topotypes.

Publ. Copeia, 1939, No. 2, July 12, pp. 97-100, fig. 1.

Type loc. Near Tianguistengo, Hidalgo, México. *Colls.,* Mrs. Hazel Roberts and E. H. Taylor, Aug. 11, 1938.

HYLA CARDENASI Taylor. Holotype.

Type. U. S. Nat. Mus., No. 84403. *Paratype.* EHT-HMS, No. 3963, near Río Frío, México.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 19, 1938 (July 10, 1939), pp. 430-432, pl. XLVII, fig. 2.

Type loc. Puebla, Puebla, México. *Coll.,* H. Ruana, Sept., 1919.

HYLA DENDROSCARTA Taylor. Holotype.

Type. U. S. Nat. Mus., No. 108679. *Paratypes.* EHT-HMS, Nos. 23236-23256, all topotypes.

Publ. Proc. U. S. Nat. Mus., Vol. 89, No. 3093, 1940, pp. 45-47, pls. 2-3.

Type loc. Cuautlapan, Veracruz, México. *Coll.,* Hobart M. Smith, Jan. 1, 1939.

HYLA ERYTHROMMA Taylor. Holotype.

Type. EHT-HMS, No. 5976.

Publ. Proc. Biol. Soc. Washington, Vol. 50, Apr. 21, 1937, pp. 48-50, pl. II, fig. 1.

Type loc. Agua del Obispo, Guerrero, México (Km. 350-351, México-Acapulco highway). *Coll.,* E. H. Taylor, July 23, 1936.

HYLA FORBESI Taylor. Holotype.

Type. EHT-HMS, No. 22276.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 513-515, pl. LVIII, figs. 1, 1a., 1b.

Type loc. Mountains 3 mi. S.W. Acultzingo, Veracruz, México. *Coll.,* Dyfrig McHattie Forbes.

HYLA HAZELAE Taylor. Holotype.

Type. EHT-HMS, No. 16263. Paratype, EHT-HMS, No. 16262, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 385-389, text figs. 1, 2a, b.

Type loc. Cerro San Felipe, 10 mi. N. of Oaxaca, Oaxaca, México. *Coll.,* E. H. Taylor, Aug. 22, 1938.

HYLA MELANOMMA Taylor. Holotype.

Type. EHT-HMS, No. 21578. *Paratypes.* EHT-HMS, Nos. 21545-21554, 21556-21558, 21560-21578, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 508-510, pl. LVIII, figs. 1, 1a, 1b.

Type loc. Seven mi. E. of Chilpancingo (Cuidad Bravos), Guerrero, México. *Coll.,* E. H. Taylor, Aug. 20, 1939.

HYLA PACHYDERMA Taylor. Holotype.

Type. U. S. Nat. Mus., No. 115029.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 208-310, pl. 27, figs. 1-4.

Type loc. Pan de Olla, south of Tezuitlán, Veracruz, México. Coll., Hobart M. Smith, Mar. 22, 1940.

HYLA PINORUM Taylor. Holotype.

Type. EHT-HMS, No. 5972.

Publ. Proc. Biol. Soc. Washington, Vol. 50, Apr. 21, 1937, pp. 46-48, pl. 2, fig. 2.

Type loc. Agua del Obispo, Guerrero, México (km. 350-351 México-Acapulco Highway). *Coll.,* E. H. Taylor, July 25, 1936.

HYLA RICKARDSI Taylor. Holotype.

Type. EHT-HMS, No. 5947. *Paratypes.* EHT-HMS, Nos. 5897-5970, topotypes; 1431-1490, 4 mi. E. Encero, Veracruz.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 385-388, pl. XLI, figs. 1-8.

Type loc. Near Potrero Viejo, Veracruz, México. *Colls.,* Mr. and Mrs. Dyfrig McH. Forbes, and E. H. Taylor, Aug. 29, 1936.

HYLA ROBERTMERTENSI Taylor. Holotype.

Type. EHT-HMS, No. 2270. *Paratypes.* EHT-HMS, Nos. 2269, 2271, Tapachula, Chs.; 2272-2280, near Tonolá, Chs.; 2290, near Asunción, Chs.

Publ. Proc. Biol. Soc. Washington, Vol. 50, Apr. 21, 1937, pp. 43-45, pl. II, figs. 3-7.

Type loc. Near Tapachula, Chiapas, México. *Colls.,* E. H. Taylor and Hobart M. Smith, Aug. 24, 1935.

HYLA ROBERTSORUM Taylor. Holotype.

Type. EHT-HMS, No. 16264. *Paratypes.* EHT-HMS, Nos. 16265-16313, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 393-396, text figs. 5, 6.

Type loc. El Chico National Park, Hidalgo, México. *Colls.,* Mr. and Mrs. Radclyffe Roberts, and E. H. Taylor, Aug. 7, 1938.

HYLA ROBUSTOFEMORA Taylor. Holotype.

Type. EHT-HMS, No. 16314.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 389-393, text figs. 3, 4.

Type loc. Cerro San Felipe, 10 mi. N. of Oaxaca, Oaxaca, México. *Coll.,* E. H. Taylor, Aug. 22, 1938.

HYLA ROZELLAE Taylor. Holotype.

Type. U.S. Nat. Mus., No. 115039.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, May 15, 1942, pp. 78-79, pl. IX, figs. 1, 1a-1c.

Type loc. Salto de Agua, Chiapas, México. *Colls.,* Dr. and Mrs. Hobart M. Smith.

HYLA SMARAGDINA Taylor. Holotype.

Type. EHT-HMS, No. 17534. *Paratypes.* EHT-HMS, Nos. 17526-17533, 17535-17554, topotypes.

Publ. Copeia, 1940, No. 1, Mar. 30, pp. 18-20, fig. 1.

Type loc. Six km. E. Cojumatlán, Michoacán, México. *Coll.,* E. H. Taylor, Sept., 1938.

HYLA WRIGHTORUM Taylor. Holotype.

Type. Univ. Michigan Mus. Zoöl., No. 79141. *Paratype.* EHT-HMS, No. 29841, topotype. [Exc. Michigan Mus. Zoöl.]

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 19, 1938 (July 10, 1939), pp. 436-439, pl. XLVII, fig. 1.

Type loc. Eleven mi. S. of Springerville, Apache county, Arizona, U.S.A. *Coll.* ?

HYLELLA AZTECA Taylor. Holotype.

Type. EHT-HMS, No. 17525.

Publ. Proc. Biol. Soc. Washington, Vol. 56, June 16, 1943, pp. 49-52.

Type loc. Tepoxtlán, Morelos. *Coll.,* E. H. Taylor, summer 1938.

HYPOPACHUS ALBOVENTER Taylor. Holotype.

Type. EHT-HMS, No. 18615. *Paratypes.* EHT-HMS, Nos. 6552-6555, near Huajintlán, Mor.; 18611-18614, 18616-18621, 2 to 8 mi. N. & E. Cuernavaca, Mor.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 522-524, pl. LX; LXIII, figs. 3, 3a.

Type loc. Eight mi. E. of Cuernavaca, Morelos, México. *Coll.,* E. H. Taylor, June 20, 1938.

HYPOPACHUS CAPRIMIMUS Taylor. Holotype.

Type. EHT-HMS, No. 18149. *Paratypes.* EHT-HMS, Nos. 1024-1030, 6555-6559, 18142-18148, 18150-18154, 18158-18159, all various localities in southern Guerrero.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 526-527, pl. LXI; pl. LXIII, figs. 1, 1a.

Type loc. Agua del Obispo, Guerrero, México. *Coll.,* E. H. Taylor, June 25, 1938.

HYPOPACHUS CUNEUS NIGRORETICULATUS Taylor. Holotype.

Type. EHT-HMS, No. 12605. *Paratypes.* EHT-HMS, Nos. 12594-12604, 12606-12690, topotypes, and localities in Campeche and Yucatán.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 518-520, pl. LIX.

Type loc. Encarnación, Campeche. México. *Coll.,* Hobart M. Smith, Oct. 1, 1936.

HYPOPACHUS MACULATUS Taylor. Holotype.

Type. EHT-HMS, No. 1023. *Paratypes.* EHT-HMS, Nos. 1016-1022, Asunción, Chs.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 524-526.

Type loc. San Ricardo, Chiapas, México. *Colls.,* E. H. Taylor and Hobart M. Smith, Sept. 2, 1935.

HYPOPACHUS OVIS Taylor. Holotype.

Type. EHT-HMS, No. 1050. *Paratypes.* EHT-HMS, Nos. 1034-1049, 1051-1093, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 520-522, pl. LVII, fig. B.

Type loc. Tepic, Nayarit, México. *Coll.,* E. H. Taylor, July 31, 1934.

KALOULA KALINGENSIS Taylor. Holotype.

Type. Originally EHT, No. 824.

Paratype. Mus. Comp. Zoöl. Harvard College, No. 14474.

Publ. Philip, Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 178-180, pl. 3, figs. 1-2.

Type loc. Balbalan, Kalinga, Mountain Prov., Luzon, P. I. *Coll.,* E. H. Taylor, Apr. 28, 1920.

KALOULA NEGROSENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 62124. Originally EHT, No. 583.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug. 1922, pp. 180-182, pl. 3, figs. 3, 4.

Type loc. Hinigaran, Negros, P. I. *Coll.,* E. H. Taylor, Apr., 1915.

KALOULA RIGIDA Taylor. Holotype.

Type. California Academy of Sciences, No. 16475. Originally EHT, No. 7681.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 176-178, pl. 3, figs. 5, 6.

Type loc. Balbalan, Kalinga, Mountain Prov., Luzon, P. I. *Coll.,* E. H. Taylor, Apr. 26, 1920.

LEPTODACTYLUS OCCIDENTALIS Taylor. Holotype.

Type. EHT-HMS, No. 3322. *Paratypes.* EHT-HMS, Nos. 3313-3321, 3323-3355, topotypes; 3310, south of Presidio, Sin.; 3311-3312, 1 to 2 mi. E. Mazatlán, Sinaloa.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 349-352, pl. 1, figs. 1, 2, 7.

Type loc. Tepic, Nayarit, México. *Coll.,* E. H. Taylor, July 28, 1934.

MEGALOPHRYS LIGAYAE Taylor. Holotype.

Type. Carnegie Museum, No. A3304. Originally EHT, No. F325.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 350-352.

Type loc. Northern part of Palawan, P. I. *Coll.,* Victor Lednicky, May, 1918.

MEGALOPHRYS STEJNEGERI Taylor. Holotype.

Type. Carnegie Museum, No. 3394. Originally EHT, No. F315.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 347-350, pl. 10, figs. 1, 1a.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Aug. 10, 1912.

MICRIXALUS DIMINUTIVA Taylor. Holotype.

Type. California Academy of Sciences, No. 61842. Originally EHT, No. 1066.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 267-269, pl. 1, figs. 3, 4; pl. 2, figs. 2, 3.

Type loc. Near Pasananka, Zamboanga Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Nov. 10, 1920.

MICROBATRACHYLUS ALBOLABRIS Taylor. Holotype.

Type. EHT-HMS, Nos. 6407. *Paratypes.* EHT-HMS, Nos. 6407A, near Córdoba; 18802, Potrero Viejo; 18803, San Juan de Gracia, Veracruz.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 502-504, pl. LVI, figs. A, B.

Type Loc. Two mi. W. of Córdoba, Veracruz, México. *Coll.,* E. H. Taylor, Aug. 20, 1936.

MICROBATRACHYLUS IMITATOR Taylor. Holotype.

Type. U. S. Nat. Mus., No. 115508.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 5, May 15, 1942, pp. 70-71.

Type loc. La Esperanza [near Escuintla], Chiapas, México. *Colls.,* Dr. and Mrs. Hobart M. Smith, May 15, 1940.

MICROBATRACHYLUS LINEATISSIMUS Taylor. Holotype.

Type. EHT-HMS, No. 24289. *Paratypes.* EHT-HMS, Nos. 24287, 24288, 24290, topotypes.

Publ. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 87-89.

Type loc. Cerro San Felipe, between 7,000-8,000 ft. near Oaxaca, Oaxaca, México. *Colls.,* R. C. Taylor and E. H. Taylor, July, 1940.

MICROBATRACHYLUS MINIMUS Taylor. Holotype.

Type. EHT-HMS, No. 6416. *Paratypes.* EHT-HMS, Nos. 6411, 6413, 6415, topotypes; 3689 near Mazatlán, Guerrero.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 507-508, pl. LVI, figs. C, D.

Type loc. Agua del Obispo (km. 350), Guerrero, México. *Coll.,* E. H. Taylor, Aug. 1, 1936.

MICROBATRACHYLUS MONTANUS Taylor. Holotype.

Type. U. S. Nat. Mus., No. 115507. *Paratype.* EHT-HMS, No. 27846 (S. 14311), Salto de Agua, Chiapas.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 5, May 15, 1942, pp. 67-69.

Type loc. Mt. Ovando, Chiapas, México (elev. 6,000 ft.). *Colls.,* Dr. and Mrs. Hobart M. Smith, Apr. 16, 1940.

MICROBATRACHYLUS OAXACAE Taylor. Holotype.

Type. EHT-HMS, No. 18197. *Paratypes.* EHT-HMS, Nos. 18188-18189, 18191-18196, 18198, 18203, 18205-18207, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 504-507.

Type loc. Cerro San Felipe, near Oaxaca, Oaxaca, México. Coll., E. H. Taylor, Aug. 18-22, 1938.

MICROHYLA FOWLERI Taylor. Holotype.

Type. Acad. Nat. Sci. Philadelphia, No. 19903.

Publ. Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 284-286, pl. 17, fig. 3; text fig. 1.

Type loc. Chieng Mai, Siam. *Coll.,* Baron R. M. de Schauensee, Mar., 1933.

MICROHYLA MAZATLANENSIS Taylor. Holotype.

Type. EHT-HMS, No. 1236. *Paratypes.* EHT-HMS, Nos. 1237-1238, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 355-357.

Type loc. Two mi. E. Mazatlán, Sinaloa, México. *Coll.,* E. H. Taylor, July 20, 1934.

* MIOPELODYTES GILMOREI Taylor. Holotype.

Type. U. S. Nat. Mus., No. 12356.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 4, 1941 (Dec.), pp. 62-69, pl. 1; text fig. 1.

Type loc. Elko Shales, Middle Miocene, near Elko, Nevada, U. S. A. *Coll.,* W. L. Sheeler.

NECTOPHRYNE LIGHTI Taylor. Holotype.

Type. ———. Originally EHT, No. 189.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 338-339, pl. 7, figs. 3, 3a.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, July, 1913.

* NEOSCAPHIOPUS NOBLEI Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6367.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, p. 204, pl. XV, figs. 5A, 5B.

Type loc. Rexroad Member formation, Upper Pliocene, Loc. 3, about 16 miles S. W. of Meade, Meade county, Kansas. *Coll.,* Claude W. Hibbard and party, 1938.

PHILAUTUS BASILANENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 60145. Originally EHT, No. 1510.

Publ. Philip. Journ. Sci., Vol. XXI, No. 2, Aug., 1922, pp. 169-171, pl. 1, figs. 1, 2.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.,* E. H. Taylor, Oct. 15, 1920.

PHILAUTUS HAZELAE Taylor. Holotype.

Type. Carnegie Museum, No. 3427. Originally EHT, No. F293.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 298-300, pl. 3, fig. 2.

Type loc. Canlaon Volcano, Negros I., P. I. *Coll.,* E. H. Taylor, Dec. 25, 1915 (not 1916 as stated).

PHILAUTUS MONTANUS Taylor. Holotype.

Type. Bureau of Science, No. 29.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 305-307, pl. 3, fig. 5.

Type loc. Mt. Bongao, 700 M., Bongao, near southern end of Tawitawi, Sulu Arch., P. I. *Coll.,* E. H. Taylor.

[Name preoccupied. *Ixalus montanus* Günther = *Philautus glandulosus* (Jerdon). Has been renamed *R[acophorus] P[hilautus] alticola* nov. nom. Ahl. = *Philautus alticola* (Ahl) (Anura III, Das Tierreich, Lief. 55, pp. 95-96.)]

PHILAUTUS POLILLENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 62250. Originally EHT, No. 351.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 171-173, pl. 2, figs. 1-4.

Type loc. Southern end of Polillo I., P. I. *Coll.,* E. H. Taylor, July 12, 1920.

PHILAUTUS WILLIAMSI Taylor. Holotype.

Type. California Academy of Sciences, No. 62253. Originally EHT, No. 356.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 167-169, pl. 1, figs. 3-6.

Type loc. Polillo I., P. I. *Coll.,* E. H. Taylor, Aug. 12, 1920.

PHILAUTUS ZAMBOANGENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 61840. Originally EHT, No. 1059.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 173-175, pl. 1, fig. 7.

Type loc. "Near Pasananka," Zamboanga Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Sept. 26, 1920.

POLYPEDATES LINKI Taylor. Holotype.

Type. California Academy of Sciences, No. 60684. Originally EHT, No. 1703.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 276-278, pl. 3, fig. 2.

Type loc. Jolo, Jolo I., P. I. *Coll.,* E. H. Taylor, Nov. 10, 1920.

PTYCHOHYLA ADIPOVENTRIS Taylor. Genotype and Holotype.

Type. EHT-HMS, No. 21592.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. 1, No. 3, 1944, pp. 41-45.

Type loc. Agua del Obispo, Guerrero, México. *Coll.,* E. H. Taylor, Aug. 31, 1939.

RANA ACANTHI Taylor. Holotype.

Type. California Academy of Sciences, No. 62577. Originally EHT, No. 539.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 523-525, pl. 2, fig. 1.

Type loc. Busuanga I., Calamian Islands, P. I. *Coll.,* E. H. Taylor.

RANA DUBITA Taylor. Holotype.

Type. Probably lost in transit to Carnegie Mus. Originally EHT, No. 1460 (Field No. 412).

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 267-268.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, June, 1913.

* RANA EPHIPPIUM Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6370.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 214-215, pl. XIV, figs. 1A, 1B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, about 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.,* Claude W. Hibbard and party, 1938.

* RANA FAYEAE Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6378.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 212-213, pl. XIV, figs. 4A, 4B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, about 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.,* Claude W. Hibbard and party, 1938.

RANA GRANDOCULA Taylor. Holotype.

Type. Carnegie Museum, No. 3501. Originally EHT, No. F 334.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 274-275, pl. 7, figs. 2, 2a.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Aug., 1912.

RANA GUERREROI Taylor. Holotype.

Type. Probably in Carnegie Mus. Originally EHT, No. 881. *Paratype.* Mus. Comp. Zoöl. Harvard Coll. No. 10482-10484.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 255-256.

Type loc. Baguio, Mountain Prov. Luzon, P. I. *Coll.,* E. H. Taylor, June 1, 1915.

RANA IGOROTA Taylor. Holotype.

Type. California Academy of Sciences, No. 61484. Originally EHT, No. F 786.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 260-262, pl. 3, fig. 1.

Type loc. Balbalan, Kalinga Subprov., Luzon, P. I. *Coll.,* E. H. Taylor, Apr. 28, 1920.

RANA LIGHTI Taylor. Holotype.

Type. EHT-HMS, No. 29836. Originally EHT, No. 1044.

Publ. Lingnan Sci. Journ. (Canton, China), Vol. 13, No. 2, Apr. 18, 1934, pp. 306-308.

Type loc. Amoy, Fukien, China. *Coll.,* S. F. Light, 1922.

* RANA MEADENSIS Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6376.

Publ. Univ. Kansas Sci. Bull., Vol. XVIII, pt. II, No. 10, Nov. 15, 1942, pp. 213-214, pl. XIV, figs. 5A, 5B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, about 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.,* Claude W. Hibbard and party, 1938.

RANA MEGAPODA Taylor. Holotype.

Type. EHT-HMS, No. 3280. *Paratypes.* EHT-HMS, Nos. 3271, 3272, 3272A, 3273-3279, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 14, Nov. 15, 1942, pp. 310-312, pl. 28, figs. 1-2.

Type loc. Near Chapala, Jalisco, México. *Coll.,* Hobart M. Smith, July 2, 1935.

RANA MELANOMENTA Taylor. Holotype.

Type. Bureau of Science, No. 1661.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 268-270.

Type loc. Papahag. Sulu Arch., P. I. *Coll.,* E. H. Taylor, Oct. 5, 1917.

RANA MERRILLI Taylor. Holotype.

Type. California Academy of Sciences, No. 62448. Originally EHT, No. F 876.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 164-166.

Type loc. Burdeos, Polillo I., P. I. *Coll.,* E. H. Taylor, July 27, 1920.

RANA MICRIXALUS Taylor. Holotype.

Type. California Academy of Sciences, No. 60143. Originally EHT, No. 1598.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 526-527, pl. 2, figs. 2, 3.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.,* E. H. Taylor, Oct. 20, 1920.

RANA MOODIEI Taylor. Holotype.

Type. Carnegie Museum, No. 3724. Originally EHT, No. 1240.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 234-236, pl. 1, fig. 5.

Type loc. Manila, P. I. *Coll.,* E. H. Taylor, Nov., 1914.

RANA PARVA Taylor. Holotype.

Type. Carnegie Museum, No. 3421. Originally EHT, No. F 409.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 241-242, pl. 3, fig. 4.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Aug., 1912.

* RANA PARVISSIMA Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6451.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, p. 217, pl. XVI, fig. 2.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.,* Claude W. Hibbard and party, 1938.

RANA PHILIPPINENSIS Taylor. Holotype.

Type. Carnegie Museum, No. A3306. Originally EHT, No. 662.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 266-267.

Type loc. [Bunawan, Agusan Prov.] Mindanao, P. I. *Coll.,* E. H. Taylor, Aug. 12, 1913.

* RANA REXROADENSIS Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6369.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 215-216, pl. XIV, figs. 3A, 3B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S.W. of Meade, Meade county, Kansas. *Coll.,* Claude W. Hibbard and party, 1938.

RANA SANCHEZI Taylor. Holotype.

Type. Bureau of Science, No. F 38.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 256-259.

Type loc. Extreme northern part of Palawan, P. I. *Coll.,* E. H. Taylor, Apr., 1918.

RANA SIERRAMADRENSIS Taylor. Holotype.

Type. EHT-HMS, No. 3963B. *Paratypes.* EHT-HMS, Nos. 3963A, 6566-6568, topotypes; 6565, 9 mi. S.W. Mazatlán, Guerrero.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 397-399, pl. XXXIX, fig. 1.

Type loc. Near Agua del Obispo, between Rincón and Cajones, Guerrero. *Coll.,* E. H. Taylor, July 1, 1932.

RANA SULUENSIS Taylor. Holotype.

Type. Bureau of Science, No. 1638.

Publ. Philip. Journ. Sci., Vol. 16, No. 3, Mar., 1920, pp. 264-266.

Type loc. Southern end of Tawitawi I., Sulu Arch., P. I. *Coll.,* E. H. Taylor, Oct., 1918.

RANA TAFTI Taylor. Holotype.

Type. California Academy of Sciences, No. 61819. Originally EHT, No. 1849.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 265-267.

Type loc. Near the Pacific Coast of Luzon, on the trail between Famy, Laguna Prov., and Infanta, Tayabas Prov., Luzon, P. I. *Colls.,* Lyman H. Taft and F. X. Williams.

*RANA VALIDA Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5133.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 216-217, pl. XIV, figs. 2A, 2B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S. W. of Meade, Meade county, Kansas. *Coll.,* Claude W. Hibbard and party, 1938.

RANA WOODWORTHI Taylor. Holotype.

Type. California Academy of Sciences, No. 61000. Originally EHT, No. 1921. *Paratypes.* EHT-HMS Nos. 29846, 29853, 29854; topotypes; Nos. 29847-29852, 29854A, Polillo I., P. I.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 519-522, pl. 1, figs. 1, 2.

Type loc. Near Los Baños, Laguna Prov., Luzon, P. I. *Coll.,* E. H. Taylor, June 12, 1921.

RANA YAKANI Taylor. Holotype.

Type. California Academy of Sciences, No. 60135. Originally EHT, No. 1545.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 262-264, pl. 1, fig. 1; pl. 2, fig. 1.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.,* E. H. Taylor, Oct. 22, 1920.

*SCAPHIOPUS ANTIQUUS Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1469.

Publ. Geol. Surv. Kansas, 1941, Report of Studies, Bull. 38, pt. 6, July 7, 1941, p. 184, fig. 2.

Type loc. Edson Beds, Ogallala formation, Middle Pliocene, Sherman county, Kansas. *Colls.,* David Dunkle and E. H. Taylor.

*SCAPHIOPUS DIVERSUS Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6368.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 202-203, pl. XV, figs. 2A, 2B.

Type loc. Rexroad Member, Upper Pliocene, Loc. 3, 16 mi. S. W. of Meade, Meade county, Kansas. *Colls.,* Claude W. Hibbard and party, 1938.

*SCAPHIOPUS PLIOBATRACHUS Taylor. Holotype.

Type. Univ. Kansas Mus. Paleo., No. 1430.

Publ. Anal. Inst. Biol. (México), Tomo 7, No. 4, 1936, pp. 515-517, Lám. 1, fig. 1.

Type loc. Edson Beds, Ogallala, Middle Pliocene, Sherman county, Kansas. *Colls.,* H. T. Martin and Claude Hibbard, 1929.

*SCAPHIOPUS STUDERI Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 1478.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 18, 1938 (July 10, 1939), pp. 408-419, pl. XLII-XLV.

Type loc. Diatomaceous marl in contact with Edson Beds, Middle Pliocene, Logan county, Kansas. *Coll.,* Frank Studer.

SYRRHOPHUS LATODACTYLUS Taylor. Holotype.

Type. EHT-HMS, No. 6807. *Paratypes.* EHT-HMS, Nos. 6805, Sabinas Hidalgo, N. L.; 6809-6812, La Placita, 8 km. S. Jacala, Hidalgo.

Publ. Univ. Kansas Sci. Bull., XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 297-401, pl. XLIII; text fig. 7.

Type loc. Huasteca Cañon, 15 mi. W. of Monterey, Nuevo León, México. *Coll.,* E. H. Taylor, June 20, 1936.

SYRRHOPHUS MODESTUS Taylor. Holotype.

Type. EHT-HMS, No. 3756. *Paratypes.* EHT-HMS, Nos. 3754, 3755, 3757, 3758, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 2, No. 14, Nov. 15, 1942, pp. 304-306, pl. 29.

Type loc. Hacienda Paso del Rio, Colima, México. *Coll.,* Dr. Hobart M. Smith, July 8, 1935.

SYRRHOPHUS NEBULOSUS Taylor. Holotype.

Type. EHT-HMS, No. 3774. *Paratypes.* EHT-HMS, Nos. 3759-3773; 3775-3779, various localities.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 353-355, pl. XXVII, figs. 3-5.

Type loc. Near Tonalá, Chiapas, México. *Colls.,* Hobart M. Smith and E. H. Taylor, Aug. 27, 1935.

SYRRHOPUS PIPILANS Taylor. Holotype.

Type. EHT-HMS, No. 3843. *Paratypes.* EHT-HMS, Nos. 6841-6842, 6844-6865, 6867-6872, all Guerrero, various localities.

Publ. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 95-98, pl. 1.

Type loc. Nine mi. S. of Mazatlán, Guerrero, México. *Coll.,* E. H. Taylor, July 22, 1936.

SYRRHOPOPHUS RUBRIMACULATA Taylor and Smith. Holotype.

Type. U.S. Nat. Mus., No. 114070.

Publ. See entry 1944h, p. 174.

Type loc. La Esperanza [near Escuintla], Chiapas, México. *Colls.,* Dr. and Mrs. Hobart M. Smith, May 13, 1940.

SYRRHOPHUS SMITHI Taylor. Holotype.

Type. U.S. Nat. Mus., No. 108594. *Paratype.* EHT-HMS, No. 23067, topotype.

Publ. Proc. U.S. Nat. Mus., Vol. 89, No. 3093, 1940, pp. 43-45, pl. 1.

Type loc. Fifteen mi. W. of Galeana, Nuevo León, México (elev. 5,200 ft.). *Coll.,* Hobart M. Smith, Oct. 13, 1939.

TOMODACTYLUS ALBOLABRIS Taylor. Holotype.

Type. EHT-HMS, No. 29568. *Paratypes.* EHT-HMS, Nos. 6944, 6945, 29567, 29569, 29570.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 351-353.

Type loc. Agua del Obispo, Guerrero, México. (Km. 351). *Coll.,* E. H. Taylor, about Aug. 1, 1940.

TOMODACTYLUS ANGUSTIDIGITORUM Taylor. Holotype.

Type. EHT-HMS, No. 18640. *Paratypes.* EHT-HMS, Nos. 3713 near San Martín, Méx.; 18641-18648, 18650, 9 mi. W. Zacapú, Mich.; 21579-21588, 4 mi. E. Carapa, Mich.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 494-496, pl. LV, figs. 1, 1a, 1b.

Type loc. Quiroga, Michoacán, México (elev., 6,880 ft.). *Coll.,* E. H. Taylor, Sept. 5, 1938.

TOMODACTYLUS MACROTYMPANUM Taylor. Holotype.

Type. EHT-HMS, No. 6838. *Paratypes.* EHT-HMS, Nos. 6815-6837, 6839-6840, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 496-499, pl. LV, figs. 2, 2a, 2b.

Type loc. [About 8 mi.] S. of Jacala, Hidalgo, México. *Coll.,* E. H. Taylor, July 2, 1936.

REPTILIA

LACERTILIA

BRACHYMELES BOULENGERI Taylor. Holotype.

Type. Originally EHT, No. 205.

Publ. Bureau of Sci. Publ., 17, Dec. 7, 1922, pp. 246-247, pl. 22, fig. 2.

Type loc. Polillo I., P. I. *Coll.,* E. H. Taylor, July 15, 1920.

BRACHYMELES BURKSI Taylor. Holotype.

Type. Originally EHT, No. 700. *Paratype.* Mus. Comp. Zoöl. Harvard Coll., No. 26584.

Publ. Philip. Journ. Sci., Vol. X, No. 5, Sec. D, Sept., 1917, pp. 275-276, pl. 1, fig. 5, text fig. 6.

Type loc. Sumagui (Liddell Plantation), Mindoro, P. I.

BRACHYMELES ELERAE Taylor. Holotype.

Type. Unnumbered specimen in the Museum of Santo Tomas, Manila, P. I.

Publ. Philip. Journ. Sci., Vol. XII, No. 5, Sec. D., Sept., 1917, pp. 273-275, pl. 1, fig. 4; text figs. 4, 5.

Type loc. "Filipinas." *Coll.* and date unknown.

BRACHYMELES PATHFINDERI Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 26581. Originally EHT, No. 750, 3d Coll. *Paratypes.* Mus. Comp. Zoöl. Harvard Coll. 26582-26583.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 104-106.

Type loc. Glan, Cotabato Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Apr., 1923.

BRACHYMELES SULUENSIS Taylor = *Brachymeles gracilis* (Fischer) (see Phil. Journ. Sci., 21, 3, 1922, 278). Holotype.

Type. Bureau of Science, No. 1989.

Publ. Philip. journ. Sci., Vol. XIII, No. 5, Sec. D., Sept., 1918, pp. 254-255, text fig. 9.

Type loc. Bubuan I., Tapiantana Group, Sulu Arch., P. I. *Coll.,* E. H. Taylor, Sept., 1917.

BRACHYMELES VERMIS Taylor. Holotype.

Type. Bureau of Science, No. 1980. *Paratype.* Mus. Comp. Zoöl. Harvard Coll., No. 26586.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D., Sept., 1918, pp. 255-257, text fig. 10.

Type loc. Bubuan, Tapian Group, Sulu Arch., P. I. *Coll.,* E. H. Taylor, Oct. 1, 1917.

BRACHYMELES WRIGHTI Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 26589. Originally EHT, No. 1126.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 106-108.

Type loc. Trinidad Farm School, Trinidad, Benguet subprov., Luzon, P. I. *Colls.,* Students of the Trinidad Farm School, 1923.

CALOTES MARMORATUS SANCHEZI Taylor. Holotype.

Type. Bureau of Science, No. 827.

Publ. Bureau of Sci. Publ. No. 17, Dec. 7, 1922, pp. 138-139, pl. II, fig. 1.

Type loc. Polillo I., P. I. *Coll.,* C. Canonizado.

* CNEMIDOPHORUS BILOBATUS Taylor. Holotype.

Type. Kansas Univ. Mus. Vert. Paleo., No. 5079.

Publ. Geol. Surv. Kansas. 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 167-171, figs. 1A-C, 2A-C.

Type loc. Rexroad Formation, Upper Pliocene, Loc. 2, sixteen mi. S.W. of Meade, Meade county, Kansas. *Colls.,* Claude Hibbard and party.

CNEMIDOPHORUS BURTI Taylor. Holotype.

Type. EHT-HMS, No. 13117. Originally EHT, No. 269. *Paratypes.* EHT-HMS, Nos. 13115-13116, 13118-13121, topotypes [originally EHT Nos. 239, 268, 311, 312, 392, 442, 443].

Publ. Univ. Kansas Sci. Bull., Vol. XXIV, No. 19, 1936 (Feb. 16, 1938), pp. 475-503.

Type loc. Near La Posa, ten mi. N.W. Guaymas, Sonora, México. *Coll.,* E. H. Taylor, July 4, 1934.

DASIA GRIFFINI Taylor. Holotype.

Type. Bureau of Science, No. 1777.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D., Mar., 1915, p. 104, pl. 1, figs. 5, 6.

Type loc. Palawan, P. I. *Coll.,* L. E. Griffin.

DIBAMUS ARGENTEUS Taylor. Holotype.

Type. Bureau of Science, No. 1691.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 107, 108, pl. 1, figs. 11, 12.

Type loc. Butuan, Agusan Prov., Mindanao. *Coll.,* E. H. Taylor, May, 1913.

DRACO DIVERGENS Taylor. Holotype.

Type. Acad. Nat. Sci. Philadelphia, No. 19938.

Publ. Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 291-292, pl. 17, fig. 4.

Type loc. Chieng Mai, Northern Siam. *Coll.,* Baron R. M. de Schauensee, Jan. 1-Mar. 1, 1933.

EMOIA RUFICAUDA Taylor. Holotype.

Type. Bureau of Science, No. 1778.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 98-99.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, June, 1912.

EUMECES COPEI Taylor. Holotype.

Type. EHT-HMS, No. 29717. EHT, Field No. 3859. *Paratypes.* EHT-HMS, Nos. 10270-10296. [Formerly EHT, Field Nos. 3860-3880, 3882-3887] all topotypes.

Publ. Proc. Biol. Soc. Washington, Vol. 46, June 30, 1933, pp. 133-137, fig. (p. 137).

Type loc. Ten mi. S.E. of Asunción in the western part of the state of México. *Colls.,* E. H. Taylor and Hobart M. Smith, Aug. 4, 1932.

EUMECES GAIGEI Taylor. Holotype.

Type. Univ. Kansas Mus. Herpetological Coll., No. 7300.

Publ. Univ. Kansas Sci. Bull., Vol. XXII, No. 11, 1935 (Nov. 15), pp. 219-223, fig. 1.

Type loc. Taos, New Mexico, U. S. A. *Coll.,* E. H. Taylor, June, 1929.

EUMECES GILBERTI RUBRICAUDATUS Taylor. Holotype.

Type. California Academy of Sciences, No. 39002.

Publ. Univ. Kansas Sci. Bull., Vol. XXIII, No. 1, 1935 (Aug. 15, 1936), pp. 446-451, pl. 39; text figs. 72 (name incorrectly spelled), 73.

Type loc. Tehachapi Mts., California.

EUBECES INDUBITUS Taylor. Holotype.

Type. EHT-HMS, No. 29715. Originally EHT, No. 1731. *Paratypes.* EHT-HMS, Nos. 10332-10343, topotypes; 10344-10356, near Asunción, México (all renumbered from field numbers).

Publ. Univ. Kansas Sci. Bull., Vol. XXI, No. 5, 1933 (Nov. 27, 1934), pp. 257-267, pls. XXIV, XXV.

Type loc. México-Cuernavaca highway, km. 63 (near Tres Marias), Morelos. *Colls.,* E. H. Taylor and Hobart M. Smith, July 9, 1932.

EUMECES INEXPECTATUS Taylor. Holotype.

Type. Univ. Kansas Museum Herpetological Coll., No. 8232.

Publ. Univ. Kansas Sci. Bull., Vol. XX, No. 13, 1932 (Oct. 1, 1932), pp. 251-259, pl. XVII.

Type loc. Citrus county, Florida. *Coll.,* Dr. Charles Burt, Mar. 7, 1930.

EUMECES OCHOTERENAE Taylor. Holotype.

Type. EHT-HMS, No. 29716. (EHT, Field No. 1015.) *Paratypes.* EHT-HMS, Nos. 10219-10228 [originally EHT, Field Nos. 1012, 1014, 1016, 1017, 1366, 1480, 1483, 1484].

Publ. Proc. Biol. Soc. Washington, Vol. 46, June 30, 1933, pp. 129-133, fig. (Original spelling *ochoteranae* is a typographical error).

Type loc. Mazatlán; "4 mi. north of Chilpancingo, Guerrero, México." In error. (The locality Mazatlán is 21 km. south of Chilpancingo by highway, about 15 km. by straight line.) *Colls.,* E. H. Taylor and Hobart M. Smith, June 26, 1932.

EUMECES PARVIAURICULATUS Taylor. Holotype.

Type. U. S. Nat. Mus., No. 47536.

Publ. Proc. Biol. Soc. Washington, Vol. 46, Oct. 26, 1933, pp. 178-181, fig. 2.

Type loc. Near Alamos, Sonora, México. *Coll.,* E. A. Goldman, Jan. 5, 1899.

EUMECES PARVULUS Taylor. Holotype.

Type. U. S. Nat. Mus., No. 56903.

Publ. Proc. Biol. Soc. Washington, Vol. 46, Oct. 26, 1933, pp. 175-178, fig. 1.

Type loc. Tepic, Nayarit, Mexico. *Coll.,* Unknown, Apr. 10, 1910.

* EUMECES STRIATULUS Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5079.

Publ. Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 171-172, figs. 3A-D, 4A, B.

Type loc. Rexroad Formation, Upper Pliocene, Loc. 2, 16 mi. S.W. of Meade, Meade county, Kansas. *Colls.,* Claude W. Hibbard and party, 1938.

* EUMECOIDES HIBBARDI Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5099.

Publ. Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 173-174, figs. 5A-D.

Type loc. Rexroad Formation, Upper Pliocene, Loc. 2, 16 mi. S.W. of Meade, Meade county, Kansas. *Colls.,* Claude W. Hibbard and party, 1936.

* EUMECOIDES MYLOCOELUS Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 5115.

Publ. Geol. Survey Kansas, 1941, Report of Studies, Bull. 38, pt. 5, July 7, 1941, pp. 174-176, figs. 6A-D.

Type loc. Rexroad Formation, Upper Pliocene, Loc. 2, 16 mi. S.W. of Meade, Meade county, Kansas. *Colls.,* Claude W. Hibbard and party, 1936.

GEKKO MINDORENSIS Taylor. Holotype.

Type. Carnegie Museum, No. 2098. Originally EHT, No. 499.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 115-118, fig. 2.

Type loc. Pocanil Point, Mindoro, P. I. *Coll.,* E. H. Taylor, May 4, 1916.

GEKKO PALAWANENSIS Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 26136; and paratype 26137, topotype, and EHT-HMS, Nos. 29841-29843, topotypes. Type originally EHT, No. 1467 3d Coll.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 99-101.

Type loc. Thumb Peak, Palawan I., P. I. *Coll.,* E. H. Taylor, Oct. 23, 1923.

GEKKO POROSUS Taylor. Holotype.

Type. California Academy of Sciences, No. 60526. Originally EHT, unnumbered.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 185-187, pl. 5, fig. 2.

Type loc. Itbayat I., Batan Ids. (Between Luzon and Formosa). *Coll.,* G. I. Lopez, Nov. 21, 1921.

GEKKO SMARAGDINUS Taylor. Holotype.

Type. California Academy of Sciences, No. 62336. Originally EHT, No. 260. *Paratype.* EHT-HMS, No. 29877, topotype.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 187-190, pl. 5, fig. 1.

Type loc. Polillo I., P. I. *Coll.,* E. H. Taylor, July 12, 1920.

GYMNODACTYLUS AGUSANENSIS Taylor. Holotype.

Type. Bureau of Science, No. R1686.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 90-92.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, June, 1913.

GYMNODACTYLUS ANNULATUS Taylor. Holotype.

Type. (Cotypes) Bureau of Science, R1686-1687.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 92-93.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, July, 1913.

HEMIDACTYLUS LUZONENSIS Taylor. Holotype.

Type. Bureau of Science, No. 1774.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 93-94.

Type loc. Manila, P. I. *Coll.,* Manila high school student (name not recorded); date unknown.

HEMIPHYLLODACTYLUS INSULARIS Taylor. Holotype.

Type. Carnegie Museum, No. 2052. Originally EHT, No. 490.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 237-239, pl. 1, figs. 6, 7; text fig. 4.

Type loc. Sumagui, Mindoro, P. I. Coll., E. H. Taylor, May 20, 1916.

INSULASAURUS WRIGHTI Taylor. Holotype.

Type. Museum Comp. Zoöl. Harvard College, No. 26301. Originally EHT, No. 1478.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 103-104.

Type loc. Thumb Peak (elevation 1,000 M.) near Iwahig, Palawan I., P. I. *Coll.,* E. H. Taylor, Oct. 26, 1923.

LEIOLOPISMA FORBESORUM Taylor. Holotype.

Type. EHT-HMS, No. 10043. *Paratypes.* EHT-HMS, Nos. 10035-10042, 10044-10045, topotypes.

Publ. Copeia 1937, No. 1, Apr. 10, pp. 8-11.

Type loc. LaPlacita, Hidalgo, México (8 mi. S. of Jacala), elev., about 7,000. *Coll.,* E. H. Taylor, July 2, 1936.

LEIOLOPISMA PULCHELLUM GRANDE Taylor. Holotype.

Type. Carnegie Museum, No. 2202, and paratype 2203. Type originally EHT, No. 899.

Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 374-377.

Type loc. Canlaon Volcano, elevation, 900, Negros, P. I. *Coll.,* E. H. Taylor, Dec. 22, 1915.

LEIOLOPISMA SILVICOLUM Taylor. Holotype.

Type. EHT-HMS, No. 10033. *Paratype.* EHT-HMS, No. 10034, topotype.

Publ. Copeia 1937, No. 1, Apr. 10, pp. 5-7.

Type loc. Ten miles S.E. of Córdoba near San Lorenzo, Veracruz, México. *Coll.,* E. H. Taylor, Aug. 19, 1936.

LEPIDODACTYLUS AUREOLINEATUS Taylor. Holotype.

Type. Bureau of Science, No. 1775.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 97-98.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, June, 1913.

LEPIDODACTYLUS CHRISTIANI Taylor. Holotype.

Type. Carnegie Museum, No. 1747. Originally EHT, No. 900.

Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 368-370, pl. II, fig. 1.

Type loc. Mt. Canlaon [Volcano], Negros, P. I., elevation, 700 M. *Coll.,* E. H. Taylor, Dec. 23, 1915.

LEPIDODACTYLUS DIVERGENS Taylor. Holotype.

Type. Bureau of Science, No. 2026.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 242-245, pl. 1, figs. 1-3.

Type loc. Great Govenen I, near Basilan, P. I. *Coll.,* E. H. Taylor, Sept., 1917.

LEPIDODACTYLUS HERREI Taylor. Holotype.

Type. Bureau of Science, No. 480.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 529-531.

Type loc. Luzurriaga, Oriental Negros. *Coll.,* Albert C. Herre, Mar. 14, 1922.

LEPIDODACTYLUS NAUJANENSIS Taylor. Holotype.

Type. Carnegie Museum, No. 2050. Originally EHT, No. 2006.

Publ. Philip Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 113-115.

Type loc. Naujan Lake, Mindoro, P. I. *Coll.,* E. H. Taylor, Apr. 25, 1916.

LEPIDOPHYMA SYLVATICA Taylor [= *Gaigeia sylvatica* (Taylor)]. Holotype.

Type. EHT-HMS, No. 16259. *Paratypes.* EHT-HMS, Nos. 16260, 16261, topotypes.

Publ. Copeia 1939, No. 3, Sept. 9, pp. 131-133, figs. 1-2.

Type loc. Seven mi. N. of Zacualtipan, Hidalgo, México. *Coll.,* E. H. Taylor, Aug. 10, 1938.

LUPEROSAURUS COMPRESSICORPUS Taylor. Holotype.

Type. Bureau of Science, No. 1781.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 96-97.

Type loc. Limay, Bataan Prov., Luzon, P. I. (Collector and date unknown.)

LUPEROSAURUS JOLOENSIS Taylor. Holotype.

Type. Bureau of Science, No. 1872.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 235-237, pl. 1, fig. 8, text fig. 3.

Type loc. Siet Lake, Jolo, P. I. *Coll.,* E. H. Taylor, Sept. 22, 1917.

MABUYA BONTOCENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 61331. Originally EHT, No. 696.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 532-534.

Type loc. Mountain Trail, Bontoc subprov., Luzon, P. I. *Coll.,* E. H. Taylor, April, 1920.

MABUYA ENGELI Taylor. Holotype.

Type. ———. Originally EHT, 577, 3d Coll. *Paratypes.* Mus. Comp. Zoöl. Harvard Coll., Nos. 26289, 26290-26300.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 101-102.

Type loc. Saub, Cotabato Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, April, 1923.

PHYLLODACTYLUS BORDAI Taylor. Holotype.

Type. EHT-HMS, No. 27732. *Paratypes.* EHT-HMS, Nos. 10997, 27733, topotypes; 21808, near Agua Bendita, Guerrero.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 6, May 15, 1942, pp. 93-96, 112, fig. 1.

Type loc. Six mi. north of Taxco, Guerrero, México (elevation, 5,600). *Coll.,* E. H. Taylor, Aug. 26, 1941.

PHYLLODACTYLUS MAGNATUBERCULATUS Taylor. Holotype.

Type. EHT-HMS, No. 10995.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 20, 1940), pp. 547-549.

Type loc. Acapulco, Guerrero, México. *Coll.,* Hobart M. Smith, Oct. 10, 1936.

PHYLLODACTYLUS MAGNUS Taylor. Holotype.

Type. EHT-HMS, No. 21783. *Paratypes.* EHT-HMS, Nos. 11035, Tonolá, Chs.; 11038-11044, 11047-11049, 21765-21771, 21784-21786, various localities in Guerrero.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. I, No. 6, May 15, 1942, pp. 99-103, fig. 3.

Type loc. Tierra Colorada, Guerrero. *Coll.,* E. H. Taylor, Sept. 2, 1939.

PHYLLODACTYLUS MURALIS Taylor. Holotype.

Type. EHT-HMS, No. 10902. *Paratypes.* EHT-HMS, Nos. 10883-10901, 10903-10939, topotypes; 11046, San Gerónimo, Oax. [In type description, Nos. 10993-10939 read 10903-10939.]

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 543-547, text fig. 7.

Type loc. Near Totolapam, Oaxaca, Oaxaca, México. *Coll.,* Hobart M. Smith, Aug. 22, 1935.

PTYCHOZOON INTERMEDIA Taylor. Holotype.

Type. Bureau of Science, No. 1776.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 94-96.

Type loc. Bunauan, Agusan, Mindanao, P. I. *Coll.,* E. H. Taylor, July 12, 1912.

SIAPHOS AURICULATUM Taylor. Holotype.

Type. Carnegie Museum, No. 1737. Originally EHT, No. 894.

Publ. Philip. Journ. Sci., Vol. 12, No. 6, Sec. D, Nov., 1917, pp. 377-378, pl. II, fig. 2.

Type loc. Canlaon Volcano, elevation, 900 M., Negros I., P. I. *Coll.,* E. H. Taylor, Dec. 23, 1915.

SIAPHOS HERREI Taylor. Holotype.

Type. California Academy of Sciences, No. 62262. Originally EHT, No. 208.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 194-196, pl. 7, fig. 1.

Type loc. Polillo I., P. I. *Coll.,* E. H. Taylor, July, 1920.

SIAPHOS KEMPI Taylor. Holotype.

Type. Carnegie Museum, No. 1734. Originally EHT, No. 2016.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 118-120, text fig. 3.

Type loc. Naujan Lake, Mindoro, P. I. *Coll.,* E. H. Taylor, Apr. 23, 1916.

SPHENOMORPHUS ARBOREUS Taylor. Holotype.

Type. Carnegie Museum, No. 1891. Originally EHT, No. 413.

Publ. Philip. Journ. Sci., Vol. 12, No. 6, Nov., 1917, pp. 373-374, pl. 1.

Type loc. Mt. Canlaon [Volcano], Negros I., P. I. *Coll.,* E. H. Taylor, Dec. 20, 1915.

SPHENOMORPHUS BAKERI Taylor. Holotype.

Type. California Academy of Sciences, No. 61330. Originally EHT, unnumbered.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 193-194.

Type loc. Haight's Place, Pauai, Benguet, Mountain Prov., Luzon, P. I. *Coll.,* Charles Fuller Baker, Apr., 1921.

SPHENOMORPHUS BEYERI Taylor. Holotype.

Type. California Academy of Sciences, No. 61183. Originally EHT, No. 17.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 283-285.

Type loc. Mt. Banajao (elev., about 1,500 M.) Laguna Prov., Luzon, P. I. *Coll.,* E. H. Taylor, May 31, 1920.

SPHENOMORPHUS BIPARIETALIS Taylor. Holotype.

Type. [Erroneously stated to be in EHT Coll.] Bureau of Science, Manila, P. I., No. 1991. *Paratypes.* In Mus. of Comp. Zoöl. Harvard Coll. Nos. 20439, 26384-26385.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 249-251, text fig. 7.

Type loc. Lapac I., Sulu Islands, P. I. *Coll.,* E. H. Taylor, Sept. 28, 1917.

SPHENOMORPHUS COXI Taylor. Holotype.

Type. Bureau of Science, No. 1782.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 100-101, pl. 1, figs. 1, 2.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, June, 1912.

SPHENOMORPHUS CURTIROSTRIS Taylor. Holotype.

Type. Bureau of Science, No. R1695.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 101-102.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Sept. 8, 1912.

SPHENOMORPHUS JAGORII DIVERGENS Taylor. Cotypes.

Type. (Cotypes) EHT-HMS, Nos. 29837-29840, Calapan, Mindoro. Originally EHT, Nos. 966, 1001, 1002, 2348. Carnegie Museum, Nos. 1761-1766, 1767-1774, 1776, 1778.

Publ. Bureau of Sci. Publ. 17, Dec. 7, 1922, p. 194.

Type loc. Mt. Maquiling, Luzon; Naujan, Mindoro; Sumagui, Mindoro; from Calapan, Mindoro. *Coll.,* E. H. Taylor, various dates.

SPHENOMORPHUS JAGORII GRANDIS Taylor. Holotype.

Type. Carnegie Museum, No. 1722. Originally EHT, No. 1414.

Publ. Bureau of Sci. Manila, Publ. 17, Dec. 7, 1922, pp. 195-196, fig. 28.

Type loc. Canlaon Volcano, Negros I., P. I. *Coll.,* E. H. Taylor, Dec. 25, 1915.

SPHENOMORPHUS LEDNICKYI Taylor. Holotype.

Type. Carnegie Museum, No. 2643. Originally EHT, No. 1992.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 120-121, text fig. 4.

Type loc. Masbate I., P. I. *Coll.,* Victor E. Lednicky, June, 1917.

SPHENOMORPHUS LLANOSI Taylor. Holotype.

Type. Unnumbered specimen in the Santo Tomás Museum, Manilla, P. I.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 121-123, pl. II.

Type loc. "Probably from Luzon." Collector and date unknown.

SPHENOMORPHUS MINDANENSIS Taylor. Holotype.

Type. Bureau of Science, No. 1690.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 99-100, pl. 1, figs. 1, 2.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Sept., 1912.

SPHENOMORPHUS PALUSTRIS Taylor. Holotype.

Type. Bureau of Science, No. 1687.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 102-104.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Sept. 16, 1912.

SPHENOMORPHUS STEJNEGERI Taylor. Holotype.

Type. California Academy of Sciences, No. 61182. Originally EHT, No. 16.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 537-538.

Type loc. Mt. Banajao, Laguna Prov., Luzon, P. I. *Coll.,* E. H. Taylor, May 30, 1920.

TROPIDOPHORUS RIVULARIS Taylor. Holotype.

Type. Bureau of Science, No. 1780.

Publ. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, Mar., 1915, pp. 106-107, figs. 9, 10.

Type loc. Bunauan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, June, 1912.

TROPIDOPHORUS STEJNEGERI Taylor. Holotype.

Type. California Academy of Sciences, No. 60230. Originally EHT, No. 1538.

Publ. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 285-287, pl. 4, fig. 1.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.,* E. H. Taylor, Oct. 22, 1920.

SERPENTES

ANOMALEPIS ASPINOSUS Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 14782.

Publ. Proc. New England Zoöl. Club, Vol. XVII, June 26, 1939, pp. 92-93, pl. V, figs. 4-7.

Type loc. Perico, Perú. *Coll.,* G. K. Noble.

ANOMALEPIS DENTATUS Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 29220.

Publ. Proc. New England Zoöl. Club, Vol. XVII, June 26, 1939, pp. 90-91, pl. V, figs. 1-3.

Type loc. Barro Colorado, Canal Zone. *Coll.,* James Zetek (recently E. R. Dunn claims to have collected the specimen; but on the invoice of specimens sent from Harvard, James Zetek is named collector).

BOIGA DENDROPHILA DIVERGENS Taylor. Holotype.

Type. Carnegie Museum, No. 2143. Originally EHT, No. 186.

Publ. Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 201-203.

Type loc. Mt. Maquiling, Laguna Prov., Luzon, P. I. *Coll.,* E. H. Taylor, Nov. 12, 1913.

BOIGA SCHULTZEI Taylor. Cotype.

Type. (Cotypes) Unnumbered spec. Willie Schultze, Manila, P. I., Collection; and Museum Comp. Zoöl. Harvard Coll., No. 25791.

Publ. Philip. Journ. Sci. Vol. 22, No. 5, May, 1923, pp. 552-553, pl. 3, fig. 3.

Type loc. Palawan, P. I. *Coll.,* C. M. Weber.

CALAMARIA GERVAISII IRIDESCENS Taylor. Holotype.

Type. Carnegie Museum, No. 8806. Originally EHT, No. 201.

Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D., Nov., 1917, pp. 360-362.

Type loc. Canlaon Volcano, Negros I., elevation, 900 M. *Coll.,* E. H. Taylor, Dec. [23-25], 1915.

CALAMARIA HOLLANDI Taylor. Holotype.

Type. California Academy of Sciences, No. 60471. Originally EHT, No. 1255.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 550-552.

Type loc. Port Holland, Basilan, P. I. Coll., E. H. Taylor, Oct., 1920.

CALAMARIA JOLOENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 60901. Originally EHT, No. 1855.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 203-204, pl. 7, figs. 2, 3.

Type loc. Central part of Jolo I., Sulu Arch., P. I. *Coll.,* E. H. Taylor, Oct. 30, 1920.

CALAMARIA POLILLENSIS Taylor. Holotype.

Type. California Academy of Sciences, No. 62455. Originally EHT, No. 341A.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 549-550.

Type loc. Polillo, Polillo I., P. I. *Coll.,* E. H. Taylor, July, 1921.

CALAMARIA SULUENSIS Taylor. Holotype.

Type. Bureau of Science, No. 1837.

Publ. Bureau of Science Manila Publ. No. 16, Feb. 11, 1922, pp. 189-190.

Type loc. Cagayan, Sulu I., P. I. *Coll.,* E. H. Taylor, Nov., 1917.

CALAMARIA TROPICA Taylor. Holotype.

Type. California Academy of Sciences, No. 62069. Originally EHT, No. 1255.

Publ. Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 194-195.

Type loc. Coastal mountains near Naujan, Mindoro, P. I. *Coll.,* E. H. Taylor, May 2, 1916.

CONOPSIS BISERIALIS Taylor and Smith. Holotype.

Type. EHT-HMS, No. 23648. *Paratypes.* EHT-HMS, Nos. 16244-16245, 21488, 23647-23648, 23696-23697, topotypes; 4702, 4757-4759, 4759A, 4760-4762, 5313, 15 mi. S.E. Zitácuaro, Mich.; 4708-4719, 4721, 5091A, 5092-5101, 5101A, 5102-5108, 5300, 23635, near Tres Cumbres, Morelos.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 15, Nov. 15, 1942, pp. 333-337, pl. XXXI, fig. 1; pl. XXXV, fig. 9; text figs. 2-3.

Type loc. Ten mi. W. of Villa Victoria, México, México. *Coll.,* E. H. Taylor, 1940.

CROTALUS SEMICORNUTUS Taylor. Holotype.

Type. EHT-HMS, No. 23014.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 4, pp. 52-55, pl. VII.

Type loc. Mojárachic, Chihuahua, México. *Coll.,* Irving Knobloch, 1939.

CROTALUS TRANSVERSUS Taylor. Holotype.

Type. EHT-HMS, No. 30001. *Paratype.* EHT-HMS, No. 15879.

Publ. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 4, pp. 47-52, pl. VI.

Type loc. "55 km. S.W. México (city) near Tres Marias (Tres Cumbres), Morelos. *Coll.,* E. Powell, Aug., 1942.

CROTALUS TRISERIATUS GLOYDI Taylor. Holotype.

Type. EHT-HMS, No. 23645.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I, No. 7, 1941 (Dec. 30), pp. 130-132, text fig. 7.

Type loc. Cerro San Felipe (elev., 10,000 ft.) near Oaxaca, Oaxaca, México. *Coll.,* E. H. Taylor, 1940.

CYCLOCORUS NUCHALIS Taylor. Holotype.

Type. California Academy of Sciences, No. 62558. Originally EHT, No. 1428.

Publ. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 543-545, pl. 3, fig. 1-2.

Type loc. Pasananka, Zamboanga Prov., Mindanao, P. I. *Coll.,* E. H. Taylor.

DRYOCALAMUS McCRORYI Taylor. Holotype.

Type. California Academy of Sciences, No. 60346. Originally EHT, No. 1517.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 197-199, pl. 6, figs. 1-3.

Type loc. Abung-Abung, Basilan I., P. I. *Coll.,* E. H. Taylor, Oct. 23, 1920.

DRYOPHIS GRISEUS Taylor. Holotype.

Type. Bureau of Science, No. 271.

Publ. Bureau of Science Manila Publ. No. 16, Feb. 11, 1922, pp. 221-222.

Type loc. Camiguin I., Cagayan Islands, P. I. *Coll.,* R. C. McGregor, 1907.

DRYOPHIS PRAEOCULARIS Taylor. Holotype.

Type. Carnegie Museum, No. 2617. Originally EHT, No. 408.

Publ. Bureau of Sci. Manila Publ., 16, Feb. 11, 1922, pp. 222-224, pl. 28, text fig. 19.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Mar. 12, 1913.

FICIMIA DESERTORUM Taylor [= *Gyalopion desertorum* (Taylor)]. Holotype.

Type. EHT-HMS, No. 4576 (originally EHT, Field No. 385).

Publ. Proc. Biol. Soc. Washington, Vol. 49, May 1, 1936, pp. 51-52.

Type loc. Twelve km. N.W. of Guaymas, Sonora. *Coll.,* E. H. Taylor, July 6, 1934.

FICIMIA RUSPATOR Smith and Taylor. Holotype.

Type. EHT-HMS, No. 23646.

Publ. Journ. Washington Acad. Sci., Vol. 31, No. 8, Aug. 15, 1941, pp. 364-365, figs. 5, 10, 12.

Type loc. Three mi. E. of Tixtla (about ten mi. E. of Chilpancingo), Guerrero, México. *Coll.,* E. H. Taylor, July 29, 1940.

FICIMIA STRECKERI Taylor. Holotype.

Type. Univ. Kansas Mus. Herpetological Coll., No. 4140.

Publ. Copeia 1931, No. 1 (Mar. 31), pp. 5-7.

Type loc. Three mi. E. Rio Grande City, Texas. *Coll.,* E. H. Taylor, July 13, 1940.

GEOPHIS BLANCHARDI Taylor and Smith. Holotype.

Type. EHT-HMS, No. 5194. *Paratypes.* EHT-HMS, Nos. 5479-5483.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 13, 1938 July 10, 1939), pp. 245-247, text figs. 2, a-d.

Type loc. About two mi. S.W. Acultzingo, Veracruz, México. *Coll.,* E. H. Taylor, Aug. 14, 1936.

GEOPHIS MACULIFERA Taylor. Holotype.

Type. EHT-HMS, No. 23552.

Publ. Univ. Kansas Sci. Bull., Vol. XXVII, pt. I. No. 7, 1941 (Dec. 30), pp. 119-121, text fig. 1.

Type loc. On the Húetamo Road, near the village of Cicio, Michoacán, México. *Coll.,* E. H. Taylor, Aug. 5, 1940.

HEMIBUNGARUS MCCLUNGI Taylor. Holotype.

Type. Bureau of Science, No. 24.

Publ. Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 272-273, pl. 33, fig. 3; pl. 34, figs. 3, 4.

Type loc. Polillo I., P. I. *Coll.,* C. Canonizado, Oct., 1909.

HOLARCHUS BURKSI Taylor. Holotype.

Type. Carnegie Museum, No. 2575. Originally EHT, No. 200.

Publ. Philip Journ. Sci., Vol. XIII, No. 6, Sec. D, Nov., 1918, pp. 365-367.

Type loc. Sumagui, Mindoro, P. I. *Coll.,* Clark Burks, Dec., 1916.

HOLARCHUS MACULATUS Taylor. Holotype.

Type. Carnegie Museum, No. 2517. Originally EHT, No. 40.

Publ. Philip. Journ. Sci., Vol. XIII, No. 6, Sec. D, Nov., 1918, pp. 364-365, pl. 1.

Type loc. Bunawan, Agusan, Mindanao, P. I. (Two spellings of town: Bunauan, Bunawan.) *Coll.,* E. H. Taylor, Aug., 1912.

HOLARCHUS PERKINSI Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard College, No. 25725. Originally EHT, No. 1164.

Publ. Philip. Journ. Sci., Vol. 26, No. 1, Jan., 1925, pp. 108-109.

Type loc. Culion, Culion I., Calamianes group, P. I. *Coll.,* Granville A. Perkins, Sept., 1923.

HYPSIGLENA TORQUATA DUNKLEI Taylor. Holotype.

Type. Mus. Comp. Zoöl. Harvard Coll., No. 42594.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 16, 1938 (July 10, 1939), pp. 374-375.

Type loc. Hda. La Clementina near Forlón, Tamaulipas, México. *Coll.,* David Dunkle, Aug. 10, 1934.

LAMPROPELTIS KNOBLOCHI Taylor. Holotype.

Type. EHT-HMS, No. 23017. *Paratype.* EHT-HMS, No. 23016, topotype.

Publ. Copeia, 1940, No. 4, Dec. 27, pp. 253-255, text figs. 1, 2.

Type loc. Mojárachic, Chihuahua, México. *Coll.,* Irving Knobloch, 1939.

LEPTODEIRA BRESSONI Taylor. Holotype.

Type. EHT-HMS, No. 5172. *Paratypes.* EHT-HMS, Nos. 4617, 5173, topotypes; 4619, Quesería, Col.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 15, 1938 (July 10, 1939), pp. 321-325, pl. XXXI, fig. 4; pl. XXXIII, fig. 4; text fig. 2.

Type loc. Hda. El Sabino, 20 mi. S. Uruapan, Michoacán, México. *Coll.,* Don Julio Raymond Bresson.

LEPTODEIRA SMITHI Taylor. Holotype.

Type. EHT-HMS, No. 5187. *Paratypes.* EHT-HMS, Nos. 4633, 5186, 5188, all topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXV, No. 15, 1938 (July 10, 1939), pp. 334-336, pl. XXXI, fig. 2.

Type loc. Hda. El Sabino, 19 mi. S. of Uruapan, Michoacán, México. *Coll.,* Hobart M. Smith, Aug. 2, 1936.

LEPTOTYPHLOPS ATER Taylor. Holotype.

Type. U. S. Nat. Mus., No. 79957.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 536-538, text fig. 4.

Type loc. Managua, Nicaragua, C. A. *Coll.,* H. C. Kellers.

LEPTOTYPHLOPS BRESSONI Taylor. Holotype.

Type. EHT-HMS, No. 5247.

Publ. Copeia, 1939, No. 1, Mar. 9, pp. 5-7, pl. 1, figs. 7-8.

Type loc. Hda. El Sabino, Urupuan, Michoacán, México. *Coll.,* Don Julio Bresson.

LEPTOTYPHLOPS MAGNAMACULATA Taylor. Holotype.

Type. U. S. Nat. Mus., No. 54760.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 532-533, text fig. 1.

Type loc. Utilla Id., Honduras, C. A. *Coll.,* F. J. Dyer.

LEPTOTYPHLOPS NASALIS Taylor. Holotype.

Type. U. S. Nat. Mus., No. 16134.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 535-536, text fig. 3.

Type loc. Managua, Nicaragua, C. A. *Coll.* ———.

LEPTOTYPHLOPS RUFIDORSUM Taylor. Holotype.

Type. U. S. Nat. Mus., No. 49993.

Publ. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 533-535, text fig. 2.

Type loc. Lima, Perú. *Coll.,* Townsend.

NAJA NAJA PHILIPPINENSIS Taylor. Holotype.

Type. Bureau of Science, No. 7.

Publ. Bureau of Sci. Manila, Publ. No. 16, Feb. 11, 1922, pp. 265-268.

Type loc. "Collected in Manila." *Coll.,* C. Canonizado, date ———.

NATRIX BARBOURI Taylor. Holotype.

Type. California Academy of Sciences, No. 61552. Originally EHT, No. 939.

Publ. Philip. Journ. Sci. Vol. 21, No. 3, Sept., 1922, pp. 291-293.

Type loc. Balbalan, Kalinga subprov., Luzon, P. I. *Coll.,* E. H. Taylor, April 26, 1920.

NATRIX DENDROPHIOPS NEGROSENSIS Taylor. Holotype.

Type. Carnegie Museum, No. 2261. Originally EHT, No. 128.

Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 356-358, text fig. 1.

Type loc. Canlaon Volcano, Negros I, P. I. *Coll.,* E. H. Taylor, 1915.

NATRIX DESCHAUENSEE Taylor. Holotype.

Type. Acad. Nat. Sci. Philadelphia, No. 19927.

Publ. Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 300-302.

Type loc. Chieng Mai, North Siam. *Coll.,* Baron R. M. de Schauensee, between Jan. 1 — Mar. 1, 1933.

OXYBELIS POTOSIENSIS Taylor. Holotype.

Type. EHT-HMS, No. 23614 ♀.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 7, 1941 (Dec.), pp. 128-130, pl. VI, figs. 4, 5, 6.

Type loc. Thirty-eight km. N.W. of Cuidad Maiz, San Luis Potosí, México (km. 192). *Coll.,* E. H. Taylor, Sept. 7, 1940.

PSEUDOFICIMIA PULCHERRIMA Taylor and Smith. Holotype.

Type. EHT-HMS, No. 5497.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 12, Nov. 15, 1942, pp. 246-249, pl. 21, fig. 2; text figs. 3, 4.

Type loc. Huajintlán, Morelos, México. Coll., E. H. Taylor, 1938.

PSEUDORHABDIUM McNAMARAE Taylor. Holotype.

Type. Carnegie Museum, No. 2606. Originally, EHT No. 196.

Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 363-364, 365, text fig. 2.

Type loc. Canlaon Volcano, 900 M., Occidental Negros, P. I. *Coll.,* E. H. Taylor, Dec. 24, 1915.

PSEUDORHABDIUM MINUTUM Taylor. Holotype.

Type. California Academy of Sciences, No. 61544. Originally EHT, F 772.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 200-202, pl. 7, figs. 4, 5.

Type loc. Balbalan, Kalinga, Mountain Prov., Luzon, P. I. *Coll.,* E. H. Taylor, April 25, 1920.

SCAPHIODONTOPHIS ALBONUCHALIS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 110413. EHT-HMS, No. 23881, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 323-327, pl. XXIII, fig. 1; XXIV, XXV, figs. 1, 2; text figs. 1, 9.

Type loc. La Esperanza (near Escuintla), Chiapas, México. *Coll.,* Hobart M. Smith, April 23, 1940.

SCAPHIODONTOPHIS CARPICINCTUS Taylor and Smith. Holotype.

Type. U. S. Nat Mus., No. 110411.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 315-317, pl. XXII, fig. 1; text fig. 6.

Type loc. Piedras Negras, Guatemala, C. A. *Coll.,* Hobart M. Smith, June 3, 1939.

SCAPHIODONTOPHIS CYCLURUS Taylor and Smith. Holotype.

Type. EHT-HMS, No. 23618.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 318-320, pl. XXII, fig. 2; text fig. 7.

Type loc. Cuautlapan, Veracruz, México. *Coll.,* E. H. Taylor, June, 1940.

SCAPHIODONTOPHIS NOTHUS Taylor and Smith. Holotype.

Type. U. S. Nat. Mus., No. 110412.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 320-321, pl. XXIII, fig. 2; text fig. 8.

Type loc. Potrero Viejo, Veracruz, México. *Coll.,* Dyfrig McH. Forbes, March 5, 1932.

SONORA ERYTHRURA Taylor. [=*Sonora michoacanensis* Dugès]. Holotype.

Type. EHT-HMS, No. 5440.

Publ. Herpetologica, Vol. 1, July 15, 1937, pp. 69-71, pl. 1, fig. 1.

Type loc. Ten mi. S. of Taxco, Guerrero, México. *Coll.,* E. H. Taylor, July 17, 1936.

STORERIA HIDALGOENSIS Taylor. Holotype.

Type. EHT-HMS, No. 16145.

Publ. Herpetologica, Vol. 2, No. 4, July 15, 1942, pp. 78-79.

Type loc. Near Zacualtipan, Hidalgo, México. *Coll.,* E. H. Taylor, Aug. 13, 1938.

TANTILLA BREVISSIMA Taylor [=*Tantillita brevissima* (Taylor)]. Holotype.

Type. EHT-HMS, No. 4557.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 344-345, fig. 4, a-c.

Type loc. Top of low mountain near the city of Tonalá, Chiapas, México. *Coll.,* E. H. Taylor, 1935.

TANTILLA HOBARTSMITHI Taylor. Holotype.

Type. EHT-HMS, No. 4558.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 340-342, fig. 2, a-c.

Type loc. LaPosa, 10 mi. N.W. of Guaymas, Sonora, México. *Coll.,* E. H. Taylor, July 3, 1934.

TANTILLA MARTINDELCAMPOI Taylor. Holotype.

Type. EHT-HMS, No. 4550.

Publ. Trans. Kansas Acad. Sci., Vol. 39, 1936 (1937), pp. 347-348, fig. 6, a-c.

Type loc. Near El Treinta, Guerrero, on México-Acapulco highway. *Coll.,* E. H. Taylor, June 29, 1932.

THAMNOPHIS EBURATUS Taylor = *Thamnophis chrysocephalus* (Cope). Holotype.

Type. EHT-HMS, No. 5556.

Publ. Herpetologica, Vol. 1, 1940, pp. 187-189, pl. XIX, lower fig.; text fig. 2.

Type loc. Cerro San Felipe, Oaxaca, Oaxaca, México. *Colls.,* Mrs. Hazel Roberts and E. H. Taylor.

THAMNOPHIS HALOPHILUS Taylor. [=*Thamnophis phenax halophilus* (Taylor).] Holotype.

Type. EHT-HMS, No. 5560.

Publ. Herpetologica, Vol. I, 1940, pp. 183-187, pl. XIX (upper fig.); text fig. 1.

Type loc. Seven km. N. of Zacualtipan, Hidalgo, México. *Coll.,* E. H. Taylor, Aug. 12, 1938.

TOLUCA CONICA Taylor and Smith. Holotype.

Type. EHT-HMS, No. 27517. *Paratypes.* EHT-HMS, Nos. 23638, 23639, Omilteme, Guerrero.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 15, 1942, pp. 340-343, pl. XXXIV, fig. 1; text fig. 5.

Type loc. San Juan Guivini, Oaxaca, Oaxaca, México. *Coll.,* Thomas McDougall, Jan., 1941.

TOLUCA MEGALODON Taylor and Smith. Holotype.

Type. EHT-HMS, No. 23640.

Publ. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 15, 1942, pp. 338-340, pls. XXX, fig. 1; XXXV, fig. 1, text fig. 4.

Type loc. Summit Cerro San Felipe, Oaxaca, Oaxaca, México. *Coll.,* E. H. Taylor, July 10-20, 1942.

TRIMERESURUS McGREGORI Taylor. Holotype.

Type. Bureau of Science, No. 738.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 110-112, text fig. 1.

Type loc. Batan Island, Batanes Group (lying between Luzon and Formosa.) *Coll.,* Richard C. McGregor, June 12, 1907.

TRIMERESURUS WAGLERI ALBOVIRIDIS Taylor. Holotype.

Type. Carnegie Museum, No. 2433. Originally EHT, No. 432.

Publ. Philip. Journ. Sci., Vol. 12, No. 6, Sec. D, Nov., 1917, pp. 366-367.

Type loc. Isabela, Occidental Negros, P. I. *Coll.,* E. H. Taylor, Sept. 12, 1915.

TRIMOPHODON PAUCIMACULATA Taylor. Holotype.

Type. EHT-HMS, No. 709 (?).

Publ. Univ. Kansas Sci. Bull., Vol. XXIV, No. 20, 1936 (Feb. 15, 1938), pp. 527-529, pl. XLVI, fig. 1.

Type loc. Mazatlán, Sinaloa, México. *Coll.,* E. H. Taylor, July 24, 1934.

TYPHLOGEOPHIS ATER Taylor. Holotype.

Type. California Academy of Sciences, No. 62043. Originally EHT, No. 1103.

Publ. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 202-203, pl. 7, figs. 6, 7.

Type loc. Near Pasananka, Zamboanga, Mindanao, P. I.

TYPHLOPS CANLAONENSIS Taylor. Holotype.

Type. Carnegie Museum, No. 2666. Originally EHT, No. 241.

Publ. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 354-355.

Type loc. Canlaon Volcano, Negros I., P. I. *Coll.,* E. H. Taylor, Dec. 25, 1915.

TYPHLOPS DENDROPHIS Taylor. Holotype.

Type. Carnegie Museum, No. 2668. Originally EHT, No. 93.

Publ. Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 60-61.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor. Aug. 15, 1913.

TYPHLOPS LONGICAUDA Taylor. Holotype.

Type. Carnegie Museum, No. 2761. Originally EHT, No. R 99.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 108-109, pl. I, fig. 1.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, July 15, 1913.

TYPHLOPS LUZONENSIS Taylor. Holotype.

Type. Originally EHT, No. 109.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 105-106.

Type loc. Mt. Maquiling, Laguna Prov., Luzon, P. I. *Coll.,* E. H. Taylor, May 12, 1915.

TYPHLOPS MANILAE Taylor. Holotype.

Type. Unnumbered specimen in Santo Tomás Museum, Manila, P. I.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 106-108.

Type loc. "Filipinas."

TYPHLOPS MINDANENSIS Taylor. Holotype.

Type. Carnegie Museum, No. 2667. Originally EHT, No. 96.

Publ. Bureau of Sci. Manila Publ. No. 16, Feb. 11, 1922, pp. 65-66.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, Aug. 12, 1913.

TYPHLOPS RUGOSA Taylor. Holotype.

Type. Carnegie Museum, No. 2665. Originally EHT, No. R 97.

Publ. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1918, pp. 109-110.

Type loc. Bunawan, Agusan Prov., Mindanao, P. I. *Coll.,* E. H. Taylor, July 14, 1913.

TYPHLOPS SULUENSIS Taylor. Holotype.

Type. Bureau of Science, No. 2001.

Publ. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 257-259, text fig. 11.

Type loc. Bubuan, Tapian Group, Sulu Arch., P. I. *Coll.,* E. H. Taylor, Oct. 2, 1917.

TESTUDINATA

EMYS TWENTEI Taylor. Holotype.

Type. Univ. Kansas Mus. Vert. Paleo., No. 6478.

Publ. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 3, Oct. 15, 1943, pp. 249-254. pl. XX.

Type loc. High terrace sands of Pleistocene Age on north side Cimarron river, 10 miles south of Meade, Meade county, Kansas (Loc. 7). *Coll.,* Dr. Claude W. Hibbard and party.

HEOSEMYS LEYTENSIS Taylor. Holotype.

Type. An unnumbered specimen in the Zoölogical Laboratory, Univ. of the Philippines (later acquired by the Bureau of Science). Number unknown.

Publ. Philip. Journ. Sci., Vol. XVI, No. 2, Feb. 1920, pp. 131-133, pl. 1, figs. 3, 4; pl. 3, fig. 1.

Type loc. Cabalian Leyte, P. I. *Coll.,* Gregorio Lopez, date unknown.

MAMMALIA

CYNOPTERUS ARCHIPELAGUS Taylor. Holotype.

Type. EHT, No. M 345.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 182-184, fig. 8, map.

Type loc. Polillo, Polillo, P. I. *Coll.,* E. H. Taylor, July, 1920.

CROCIDURA PALA WANENSIS Taylor. Holotype.

Type. EHT, No. M 55.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 88-90, fig. 2, map.

Type loc. Sir J. Brooke Point, Palawan, P. I. *Coll.,* E. H. Taylor, Sept. 29, 1923.

CROCIDURA PARVACAUDA Taylor. Holotype.

Type. EHT, No. M 737.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 83-85, fig. 2, map.

Type loc. Saub, Cotabato, Mindanao, P. I. *Coll.,* E. H. Taylor, April 27, 1923.

EMBALLONURA ALECTO PALAWANENSIS Taylor. Holotype.

Type. EHT, No. M 72. *Paratypes.* EHT, Nos. M 68, 71.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 197-200, fig. 8, map.

Type loc. Thumb peak, Palawan, P. I. *Coll.,* E. H. Taylor, Oct. 28, 1923.

EONYCTERIS LONGICAUDA Taylor [= *Eonycteris robusta* Miller]. Holotype.

Type. EHT, No. M 561. *Paratypes.* EHT, Nos. 434-435, 438-439, 441, 446-447, 450, 561, 564.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 131-134, pl. 6, fig. 6-8, fig. 4, map.

Type loc. Montalban caves, Montalban, Rizal Province, Luzon, P. I. *Colls.,* W. Schultze, Albert Herre, and E. H. Taylor.

HIPPOSIDEROS DIADEMA ANDERSENI Taylor. Holotype.

Type. EHT, No. M 330.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 246-247, fig. 11, map.

Type loc. Near Novaliches, Rizal Province, Luzon, P. I. *Coll.,* E. H. Taylor, March, 1922.

HIPPOSIDEROS WRIGHTI Taylor. Holotype.

Type. EHT, No. M 381.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 237-239, fig. 11, map.

Type loc. Deserted mine tunnel, Baguio, Benguet (near Headwaters Gold Mine). *Coll.,* E. H. Taylor and John Suarez Wright, July 26, 1923.

INSULAEMUS CALAMIANENSIS Taylor. Holotype. Genotype.

Type. EHT, No. M 104.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 470-471, fig. 24, map.

Type loc. Sea level, Minuit, Busuanga Island, Calamianes, P. I. *Coll.,* E. H. Taylor, April 18, 1918.

MACROGLOSSUS FRUCTIVORUS Taylor. Holotype.

Type. EHT, No. M 710.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 125-126, fig. 4, map.

Type loc. Tatayan, Cotabato, Mindanao, P. I. *Coll.,* E. H. Taylor, March 5, 1923.

MEGAEROPS WETMOREI Taylor. Holotype.

Type. EHT, No. M 770.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 191-193, fig. 8, map.

Type loc. Near Tatayan, Cotabato, Mindanao, P. I. *Coll.,* E. H. Taylor, March, 1923.

MYOTIO BROWNI Taylor. Holotype.

Type. EHT, No. M 341.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 288-290, fig. 12, map.

Type loc. Near Saub, Cotabato, Mindanao, P. I. *Coll.,* E. H. Taylor, April 15, 1923.

MYOTIS HERREI Taylor. Holotype.

Type. EHT, No. M 369.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 290-292, fig. 12, map.

Type loc. Cave at Montalban, Rizal Province, Luzon, P. I. *Coll.,* W. Schultze, Albert W. Herre, and E. H. Taylor, Jan. 22, 1923.

MYOTIS JEANNEI Taylor. Holotype.

Type. EHT, No. M 340

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 284-286, fig. 12, map.

Type loc. Near Caldera, Zamboanga, Mindanao, P. I. *Coll.,* E. H. Taylor, April, 1923.

MYOTIS PATRICIAE Taylor. Holotype.

Type. EHT, No. M 353.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 286-288, fig. 12, map.

Type loc. Agusan Prov., Mindanao, P. I. *Coll.,* Collector and date unknown.

NANNOSCIURUS LUNCEFORDI Taylor. Holotype.

Type. EHT, No. M 594.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 286-288, fig. 17, map.

Type loc. Saub, Cotabato, Mindanao, P. I. *Coll.,* E. H. Taylor, April 29, 1923.

PACHYURA PALAWANENSIS Taylor [= *Suncus palawanensis* (Taylor)] Holotype.

Type. EHT, No. M 89. *Paratype.* EHT, No. M 90.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 78-80, fig. 2, map.

Type loc. Taytay, Palawan, P. I. *Coll.,* unknown, May, 1913.

PHILIPPINOPTERUS LANEI Taylor. Holotype.

Type. EHT, No. M 253. *Paratypes.* Nos. M 217-251; 253-307.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 314-320, fig. 15, map.

Type loc. Saub, Cotabato, Mindanao, P. I. *Coll.,* E. H. Taylor, April 28, 1923.

PTEROPUS TABLASI Taylor. Holotype.

Type. EHT, No. M 312.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 169-171, pl. 4, fig. 2, a-e; text fig. 6, map.

Type loc. Near Odiongan, Tablas I., P. I. *Coll.,* E. H. Taylor, Jan., 1923.

RATTUS MINDANENSIS TABLASI Taylor. Holotype.

Type. EHT, No. M 652. *Paratype.* EHT, No. M 651.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 439-440, fig. 21, map.

Type loc. Odiongan, Tablas I., P. I. *Coll.,* E. H. Taylor, Jan. 18, 1923.

RATTUS PALAWANENSIS. Holotype.

Type. EHT, No. M 32. *Paratypes.* EHT, Nos. M 27-31.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 416-419, fig. 20, map.

Type loc. Sir J. Brooke Point, Palawan, P. I. *Coll.,* E. H. Taylor, Oct., 1923.

RHINOLOPHUS BUNKERI Taylor. Holotype.

Type. EHT, No. M 367.

Publ. Philippine Land Mammals. Mon. Bureau Science, Manila, P. I., No. 30, June 30, 1934, pp. 228-229, fig. 10, map.

Type loc. Saub, Cotabato, Mindanao, P. I. *Coll.,* E. H. Taylor, April 26, 1923.

BIBLIOGRAPHY

(Papers of joint authorship are inserted in their proper chronological order)

1915 New species of Philippine lizards. Philip. Journ. Sci., Vol. X, No. 2, Sec. D, March, 1915, pp. 89-109, pl. 1.

The following are described:

Gymnodactylus agusanensis
Gymnodactylus annulatus
Hemidactylus luzonensis
Ptychozoon intermedia
Luperosaurus compressicorpus
Lepidodactylus aureolineatus
Emoia ruficauda
Sphenomorphus mindanensis
Sphenomorphus coxi
Sphenomorphus curtirostris
Sphenomorphus palustris
Dasia griffini
Tropidophorus rivularis
Dibamus argenteus

1917a Brachymeles, a genus of Philippine lizards. Philip. Journ. Sci. Vol. XII, No. 5, Sec. D, Sept., 1917, pp. 267-279, pl. 1; and text figs. 1-7.

Describes: *Brachymeles elerae,* and *Brachymeles burksi.*

1917b Snakes and Lizards known from Negros, with descriptions of new species and new subspecies. Philip. Journ. Sci., Vol. XII, No. 6, Sec. D, Nov., 1917, pp. 353-381, pls. 1, 2; Text figs. 1, 2.

Describes the following new forms:

Typhlops canlaonensis
Natrix dendrophiops negrosensis
Pseudorhabdium mcnamarae
Calamaria gervaisii iridescens
Trimeresurus wagleri alboviridis
Lepidodactylus christiani
Sphenomorphus arboreus
Siaphos auriculatum
Leiolepisma [sic] pulchellum grande

1918a Reptiles of Sulu Archipelago. Philip. Journ. Sci., Vol. XIII, No. 5, Sec. D, Sept., 1918, pp. 233-267, pls. 1-3; text figs. 1-11.

Describes:

Luperosaurus joloensis
Hemiphyllodactylus insularis
Lepidodactylus divergens
Sphenomorphus biparietalis
Brachymeles suluensis
Brachymeles vermis
Typhlops suluensis

1918b Two new snakes of the genus Holarchus with descriptions of other Philippine species. Philip. Journ. Sci., Vol. XIII, No. 6, Sec. D, Nov., 1918, pp. 359-369, pls. 1, 2.

Describes: *Holarchus maculatus,* and *Holarchus burksi.*

1919a New or rare Philippine reptiles. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1919, pp. 105-125, pl. 1, 2; text figs. 1-4.

The following species are described:

Typhlops luzonensis
Typhlops manilae
Typhlops longicauda
Typhlops rugosa
Trimeresurus mcgregori
Lepidodactylus naujanensis
Gekko mindorensis
Siaphos kempi
Sphenomorphus lednickyi
Sphenomorphus llanosi

1919b Ipon fisheries of Abra River. Philip. Journ. Sci., Vol. XIV, No. 1, Jan., 1919, pp. 127-130.

1920a Philippine turtles. Philip. Journ. Sci., Vol. 16, No. 2, Feb., 1920, pp. 111-144, pls. 1-7.

Heosemys leytensis described.

1920b Philippine Amphibia. Philip. Journ. Sci., Vol. 16, No. 3, March, 1920, pp. 213-359, pls. 1-10; text figs. 1-9. Errata pp. 649-650.

Describes:

Rana moodici
Rana parva
Rana dubita
Rana guerreroi
Rana sanchezi
Rana suluensis
Rana philippinensis
Rana grandocula
Rana melanomenta
HAZELIA
Hazelia spinosa
Philautus hazelae
Philautus montanus
Cornufer laticeps
Chaperina beyeri
Chaperina visaya
Nectophryne lighti
Megalophrys stejnegeri
Megalophrys ligayae
Ichthyophis weberi

1921 Amphibians and turtles of the Philippine Islands. Department of Agriculture and Natural Resources, Bureau of Science, Manila, Publication. No. 15, Dec., 15, 1921, pp. 1-193, pls. 1-17; text figs. 1-9.

1922a The snakes of the Philippine Islands. Department of Agriculture and Natural Resources, Bureau of Science, Manila, Publication. No. 16, Feb. 11, 1922, pp. 1-312, pls. 1-37; text figs. 1-32.

The following species are described:

Typhlops dendrophis
Typhlops mindanensis
Calamaria suluensis
Calamaria tropica
Boiga dendrophila divergens
Dryophis griseus
Dryophis preocularis
Naja naja philippinensis
Hemibungarus mcclungi

1922b Additions to the herpetological fauna of the Philippine Islands, I. Philip. Journ. Sci., Vol. 21, No. 2, Aug., 1922, pp. 161-206, pls. 1-7.

Type descriptions of the following species are given:

Rana merrilli
Cornufer cornutus
Philautus polillensis
Philautus williamsi
Philautus zamboangensis
Philautus basilanensis
Kaloula negrosensis
Kaloula kalingensis
Kaloula rigida
Bufo mcgregori
Gekko porosus
Gekko smaragdinus
Sphenomorphus bakeri
Siaphos herrei
Dryocalamus mccroryi
Calamaria joloensis
Pseudorhabdium minutum
Typhlogeophis ater

1922c Additions to the herpetological fauna of the Philippine Islands, II. Philip. Journ. Sci., Vol. 21, No. 3, Sept., 1922, pp. 257-303, pls. 1-4.

The following type descriptions appear:

Rana igorota
Rana yakani
Rana tafti
Micrixalus diminutiva
Cornufer rivularis
Cornufer montanus
Cornufer subterrestris
Polypedates linki
Sphenomorphus beyeri
Tropidophorus stejnegeri
Natrix barbouri

1922d The lizards of the Philippine Islands. Department of Agriculture and Natural Resources, Bureau of Science, Manila, Publ. No. 17, Dec. 7, 1922, pp. 1-269, pls. 1-23; text figs. 1-53.

The following described as new:

Calotes marmoratus sanchezi
Sphenomorphus jagorii divergens
Sphenormorphus jagorii grandis
Brachymeles boulengeri

1922e Herpetological fauna of Mount Makiling. The Philippine Agriculturist, Vol. XI, No. 5, Dec., 1922, pp. 127-139.

NOTE.—The last phrase in this article reads, "one lizard *Gonyocephalus bitorques* Peters." An entire line was dropped. This should read, "*one* lizard *Gonyocephalus* sp. (young) and one specimen of a small snake, *Calamaria bitorques* Peters.")

1923 Additions to the Herpetological fauna of the Philippine Islands, III. Philip. Journ. Sci., Vol. 22, No. 5, May, 1923, pp. 515-557, pls. 1-3.

The following type descriptions appear:

Ichthyophis glandulosus
Rana woodworthi
Rana acanthi
Rana micrixalus
Lepidodactylus herrei
Mabuya bontocensis
Sphenomorphus stejnegeri
Cyclocorus nuchalis
Calamaria polillensis
Calamaria hollandi
Boiga schultzei

1924 [with Noble, G. Kingsley]. A new genus of discoglossid frogs from the Philippine Islands. Amer. Mus. Nov., No. 121, June 23, 1924, pp. 1-4, text fig. 1.

The genus BARBOURULA, and *Barbourula busuangensis* are described.

1925 Additions to the herpetological fauna of the Philippines, IV. Philip. Journ. Sci., Vol. 26, No. 1, Jan. 1925, pp. 97-111.

The following species are described:

Mabuya engeli
INSULASAURUS
Insulasaurus wrighti
Brachymeles pathfinderi
Brachymeles wrighti
Holarchus perkinsi

1928 Amphibians, lizards, and snakes of the Philippines. From, Distribution of Life in the Philippines. Dept. of Agriculture and Commerce, Bureau of Science, Manila, Monograph No. 21, 1928, pp. 214-242, pls. 27-32; text figs. 51-56.

1930a A revised checklist of the snakes of Kansas. Univ. Kansas Sci. Bull., Vol. XIX, No. 5, 1929 (1930), pp. 53-62.

1930b List of reptiles and batrachians of Morton County, Kansas, reporting species new to the state fauna. Univ. Kansas Sci. Bull., Vol. XIX, No. 6, 1929 (1930), pp. 63-65.

1930c A species of lizard new to the fauna of the United States: *Eumeces callicephalus* Bocourt. Univ. Kansas Sci. Bull., Vol. XIX, No. 7, 1929 (1930), pp. 67-69.

1931a Notes on two specimens of the rare snake *Ficimia cana*, and the description of a new species of *Ficimia* from Texas. Copeia, 1931, No. 1, March 31, pp. 4-7.

Ficimia streckeri is described.

1931b The discovery of a lizard *Sceloporus torquatus cyanogenys* Cope in Texas, new to the fauna of the United States. Proc. Biol. Soc. Washington, Vol. 44, Oct. 17, 1931, pp. 129-132.

1932a *Leptodactylus albilabris* (Günther): A species of toad new to the fauna of the United States. Univ. Kansas Sci. Bull., Vol. XX, No. 11, 1932 (Oct. 1), pp. 243-245.

1932b The toad *Bufo marinus* (Linnaeus) in Texas. Univ. Kansas Sci. Bull., [with Wright, John S.] Vol. XX, No. 12, 1932 (Oct. 1), pp. 247-249.

1932c *Eumeces inexpectatus:* A new American lizard of the family Scincidae. Univ. Kansas Sci. Bull., Vol XX, No. 13, 1932 (Oct. 1), pp. 251-259, pls. XVII-XVIII.

Eumeces inexpectatus described.

1932d *Eumeces laticeps:* A neglected species of skink. Univ. Kansas Sci. Bull., Vol. XX, No. 14, 1932 (Oct. 1), pp. 263-271, pls. XIX, XX.

1933a Two new Mexican skinks of the genus Eumeces. Proc. Biol. Soc. Washington, Vol. 46, June 30, 1933, pp. 129-138, 2 text figs.

Eumeces ochoterenae and *Eumeces copei* are described.

1933b Notes on type specimens of reptiles and amphibians in the "Alfredo Dugès" Museum, Guanajuato, Mexico. Copeia, 1933, No. 2, July 20, p. 97.

1933c New Species of skinks from Mexico. Proc. Biol. Soc. Washington, Vol. 46, Oct. 26, 1933, pp. 175-182, figs. 1, 2.

Describes: *Eumeces parvulus* and *Eumeces parviauriculatus.*

1934a Notes on Chinese reptiles and amphibians. Lingnan Science Journ. Canton, China, Vol. 13, No. 2, April 18, 1934, pp. 297-310.

Rana lighti described.

1934b Zoölogical results of the third De Schauensee Siamese Expendition, Part III. Amphibians and Reptiles. Proc. Acad. Nat. Sci. Philadelphia, Vol. LXXXVI, June 13, 1934, pp. 281-310, pl. 17; text figs. 1-4.

The following species are described:

Natrix deschauenseei
Draco divergens
Microhyla fowleri

1934c Philippine land mammals. Bureau of Science Monograph. No. 30, June 30, 1934, pp. 1-548, pls. 1-25; text figs. 1-25.

The following mammals are described:

Pachyura palawanensis
Crocidura parvacauda
Crocidura palawanensis
Macroglossus fructivorus
Pteropus tablasi
Cynopterus archipelagus
Megaerops wetmorei
Eonycteris longicauda
Emballonura alecto palawanensis
Rhinolophus bunkeri
Hipposideros wrighti
Hipposideros diadema anderseni
Myotis jeannei
Myotis patriciae
Myotis browni
Myotis herrei
PHILIPPINOPTERUS
Philippinopterus lanei
Nannosciurus luncefordi
Rattus palawanensis
Rattus mindanensis tablasi
INSULAEMUS
Insulaemus calamianensis

1934d Notes on two collections of Hainan reptiles and amphibians. Lingnan Sci. Journ. (Canton, China), Vol. 13, No. 3, July 30, 1934, pp. 465-474.

1934e A new species of lizard from Mexico. Univ. Kansas Sci. Bull., Vol. XXI, No. 5, 1933 (Nov. 27, 1934), pp. 257-267, pls. XXIV, XXV.

Eumeces indubitus is described.

1934f Observations on the courtship of turtles. Univ. Kansas Sci. Bull., Vol. XXI, No. 6, 1933 (Nov. 27, 1934), pp. 269-271.

1935a A new skink from Mexico. Zoöl. Ser. Field Mus. Nat. Hist., Vol. XX, No. 10, May 15, 1935, pp. 77-80, fig. 7.

1935b *Coleonyx fasciatus,* a neglected species of gecko. Univ. Kansas Sci. Bull., Vol. XXII, No. 9, 1935 (Nov. 15), pp. 203-205.

1935c Arkansas amphibians and reptiles in the Kansas University Museum, Univ. Kansas Sci. Bull., Vol. XXII, No. 10, 1935 (Nov. 15), pp. 207-218.

1935d A new species of the genus Eumeces from New Mexico. Univ. Kansas Sci. Bull., Vol. XXII, No. 11, 1925 (Nov. 15), pp. 219-223, fig. 1.

Eumeces gaigei described.

1936a Notes on a small herpetological collection from Western Australia. Tran. Kansas Acad. Sci., Vol. 38, 1935 (April 25, 1936), pp. 341-344.

1936b Proposed changes in the nomenclature of the scincoid lizard genus Eumeces. Trans. Kansas Acad. Sci., Vol. 38, 1935 (Apr. 25, 1936), pp. 345-347.

1936c Description of a new Sonoran snake of the genus Ficimia, with notes on other Mexican species. Proc. Biol. Soc. Washington, Vol. 49, May 1, 1936, pp. 51-54.

Type description of *Ficimia desertorum.*

1936d The rediscovery of the lizard Eumeces altamirani (Dugès) with notes on two other Mexican species of the genus. Proc. Biol. Soc. Washington, Vol. 49, May 1, 1936, pp. 55-58.

1936e A taxonomic study of the cosmopolitan scincoid lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. Univ. Kansas Sci. Bull., Vol. XXIII, No. 1, 1935 (Aug. 15, 1936), pp. 1-643, pls. I-XLIII; figs. 1-84.

Eumeces gilberti rubricaudatus is described.

1936f Una nueva fauna de batracios anuros del Plioceno Medio, de Kansas. Anales Inst. Biol., (Mexico) Tomo VII, No. 4, 1936, pp. 513-529, Lam. 1, 2.

The following fossil forms are described:

Scaphiopus pliobatrachus *Bufo arenarius*
Bufo hibbardi

1936g Notes and comments on certain American and Mexican snakes of the genus Tantilla, with descriptions of new species. Trans. Kansas Acad. Sci. Vol. 39, 1936, pp. 335-348, text fig. 1-6.

Describes: *Tantilla hobartsmithi, Tantilla brevissima, Tantilla martindelcampoi.*

1936h New species of amphibia from Mexico. Tran. Kansas Acad. Sci., Vol. 39, 1936 (———), pp. 349-363, pls. 1-2.

Type descriptions of *Leptodactylus occidentalis, Eleutherodactylus pygmaeus, Eleutherodactylus hobartsmithi.*

1937a Two new lizards of the genus Leiolopisma from Mexico, with comments on another Mexican species. Copeia, 1937, No. 1, April 10, pp. 5-11.

Leiolopisma silvicolum and *Leiolopisma forbesorum* are described.

1937b New species of hylid frogs from Mexico with comments on the rare *Hyla bistincta* Cope. Proc. Biol. Soc. Washington, Vol. 50, April 21, 1937, pp. 43-54, pls. II, III.

Hyla robertmertensi, Hyla pinorum and *Hyla erythromma* are described.

1937c A new snake of the genus *Sonora* from Mexico, with comments on *S. michoacanensis.* Herpetologica, Vol. 1, July 15, 1937, pp. 69-72, pls. VI, VII.

Type description of *Sonora erythrura.*

1938a Notes on the herpetological fauna of the Mexican state of Sonora. Univ. Kansas Sci. Bull., Vol. XXIV, No. 19, 1936 (Feb. 15, 1938), pp. 475-503, pl. XLIII.

Cnemidophorus burti described.

1938b Notes on the herpetological fauna of the Mexican state of Sinaloa. Univ. Kansas Sci. Bull., Vol. XXIV, No. 20, 1936 (Feb. 15, 1938), pp. 505-537, pls. XLIV-XLVI.

Type description of *Bufo kelloggi* and *Trimorphodon paucimaculata.*

1938c Does the amphisbaenid genus *Bipes* occur in the Stated States? Copeia, 1938, No. 4, December 10, p. 202.

1939a On North American snakes of the genus *Leptotyphlops.* Copeia, 1939, No. 1, March 9, pp. 1-7, pl. 1.

Leptotyphlops bressoni is described.

1939b Two new species of the genus Anomalepis Jan, with a proposal of a new family of snakes. Proc. New England Zoöl. Club., Vol. XVII, June 26, 1939, pp. 87-96, pl. V.

Family *ANOMALEPIDAE* and *Anomalepis dentatus, Anomalepis aspinosus* are described.

1939c [with Smith, Hobart M.] Miscellaneous notes on Mexican snakes. Univ. Kansas Sci. Bull., Vol. XXV, No. 13, 1938 (July 10, 1939), pp. 239-258, pl. XXIII; text figs. 1-4.

Geophis blanchardi is described.

1939d Concerning Mexican Salamanders. Univ. Kansas Sci. Bull., Vol. XXV, No. 14, 1938 (July 10, 1939), pp. 259-313, pls. XXIV-XXIX.

The following species are described as new:

Ambystoma schmidti
Oedipus robertsi
Oedipus altamontanus
Oedipus multidentata
Oedipus smithi
Oedipus giganteus
Oedipus manni

1939e Notes on the Mexican snakes of the genus *Leptodeira* with a proposal of a new snake genus, *Pseudoleptodeira.* Univ. Kansas Sci. Bull., Vol XXV, No. 15, 1938 (July 10, 1939), pp. 315-355, pls. XXX-XXXIV; text figs. 1-7.

Pseudoleptodeira nov. gen. described, also *Leptodeira bressoni,* and *Leptodeira smithi.*

1939f On the Mexican snakes of the Genera Trimorphodon and Hypsiglena. Univ. Kansas Sci. Bull., Vol XXV, No. 16, 1938 (July 10, 1939), pp. 357-383, pls. XXXV-XXXVIII; text fig. 1.

Hypsiglena torquata dunklei is described.

1939g New species of Mexican tailless amphibia. Univ. Kansas Sci. Bull., Vol. XXV, No. 17, 1938 (July 10, 1939), pp. 385-405, pls. XXXIX-XLI; text figs. 1-2.

Type descriptions of the following:

Hyla arborescandens
Hyla rickardsi
Eleutherodactylus natator
Eleutherodactylus cactorum
Rana sierramadrensis

1939h A new anuran amphibian from the Pliocene of Kansas. Univ. Kansas Sci. Bull., Vol. XXV, No. 18, 1938 (July 10, 1939), pp. 407-419, pls. XLII-XLV.

Type description of *Scaphiopus studeri.*

1939i Frogs of the Hyla eximia group in Mexico, with descriptions of two new species. Univ. Kansas Sci. Bull., Vol. XXV, No. 19, 1938 (July 10, 1939), pp. 421-445, pls. XLVI-XLVIII.

Hyla cardenasi and *Hyla wrightorum* are described.

1939j A new bromeliad frog. Copeia, 1939, No. 2, July 12, pp. 97-100, fig. 1.

Hyla bromeliana described.

1939k A new species of the lizard genus Lepidophyma from Mexico. Copeia, 1939, No. 3, Sept. 9, pp. 131-133, figs. 1-2.

Lepidophyma sylvatica is described.

1940a A new eleutherodactylid frog from Mexico. Proc. New England Zoöl. Club, Vol. XVIII, Jan. 24, 1940, pp. 13-16, pl. I, II.

Eleutherodactylus batrachylus is described.

1940b A new *Rhyacosiredon* (Caudata) from western Mexico. Herpetologica, Vol. 1, No. 7, Jan. 29, 1940, pp. 171-176, pl. XVII.

Rhyacosiredon rivularis is described.

1940c Two new snakes of the genus *Thamnophis* from Mexico. Herpetologica, Vol. 1, No. 7, Jan. 29, 1940, pp. 183-189, pl. XIX; text figs. 1-2.

Thamnophis halophilus and *Thamnophis eburatus* are described.

1940d A new bromeliad frog from northwestern Michoacan. Copeia, 1940, No. 1, March 30, pp. 18-20, fig. 1.

Hyla smaragdina is described.

1940e Two new anuran amphibians from Mexico. Proc. U. S. Nat. Mus., Vol. 89, No. 3093, 1940, pp. 43-47, pls. 1-3.

Syrrhophus smithi and *Hyla dendroscarta* are described.

1940f A new Syrrhophus from Guerrero, Mexico. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 95-98, pl. 1.

Syrrhophus pipilans is described.

1940g Palatal sesamoid bones and palatal teeth in *Cnemidophorus*, with notes on these teeth in other saurian genera. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 119-124, pl. II.

1940h [with Knobloch, Irving W.] Report on an herpetological collection from the Sierra Madre Mountains of Chihuahua. Proc. Biol. Soc. Washington, Vol. 53, Oct. 7, 1940, pp. 125-130.

1940i New species of Mexican Anura. Univ. Kansas Sci. Bull., Vol. XXVI, No. 11, 1939 (Nov. 27, 1940), pp. 385-405, pls. XLIII and XLIV; text figs. 1-8.

Describes:

Hyla hazelae
Hyla robustofemora
Hyla robertsorum
Syrrhophus latodactylus
Eleutherodactylus vocalis

1940j New salamanders from Mexico, with a discussion of certain known forms. Univ. Kansas Sci. Bull., Vol. XXVI, No. 12, 1939 (Nov. 27, 1940), pp. 407-439, pls. XLV-XLVIII; text figs. 1-5.

The following species are described:

Bolitoglossa dimidiata
Thorius pulmonaris
Thorius narisovalis
Ambystoma bombypella
Ambystoma ordinaria
Ambystoma amblycephala
Siredon lermaensis

1940k Mexican snakes of the genus Typhlops. Univ. Kansas Sci. Bull., Vol. XXVI, No. 13, 1939 (Nov. 27, 1940), pp. 441-444, figs. 1, 2.

1940l Some Mexican serpents. Univ. Kansas Sci. Bull., Vol. XXVI, No. 14, 1939 (Nov. 27, 1940), pp. 445-487, pl. XLIX-LII; text figs. 1-9.

Tropidodipsas guerrerocnsis is described.

1940m Herpetological miscellany No. I. Univ. Kansas Sci. Bull., Vol. XXVI, No. 15, 1939 (Nov. 27, 1940), pp. 489-571, pls. LIII-LXIII; text figs. 1-7.

The following species are described as new:

Bufo gemmifer
Bufo mazatlanensis
Tomodactylus angustidigitorum
Tomodactylus macrotympanum
MICROBATRACHYLUS
Microbatrachylus albolabris
Microbatrachylus oaxacae
Microbatrachylus minimus
Hyla melanomma
Hyla forbesi
Hypopachus ovis
Hypopachus maculatus
Hypopachus caprimimus
Hypopachus alboventer
Hypopachus cuneus nigroreticulata
Leptotyphlops magnamaculata
Leptotyphlops rufidorsum
Leptotyphlops nasalis
Leptotyphlops ater
Phyllodactylus muralis
Phyllodactylus magnatuberculata

1940n A new frog from the Tarahumara Mountains of Mexico. Copeia, 1940, No. 4, Dec. 27, pp. 250-253, fig. 1.

Eleutherodactylus tarahumaraensis described.

1940o A new *Lampropeltis* from western Mexico. Copeia, 1940, No. 4, Dec. 27, pp. 253-255, text figs. 1-2.

Lampropeltis knoblochi described.

1941a New plethodont salamanders from Mexico. Herpetologica, Vol. 2, No. 3, March 25, 1941, pp. 57-65, text figs. 1-5.

Describes: *Bolitoglossa unguidentis* and *Bolitoglossa arborea.*

1941b Extinct lizards from Upper Pliocene deposits of Kansas. Univ. Kansas Publ., State Geol. Surv. Kansas, Bull. No. 38, 1941 Reports of Studies, part 5, July 7, 1941, pp. 165-176, figs. 1-6.

Describes:

Eumeces striatulus
EUMECOIDES
Eumecoides hibbardi
Eumecoides mylocoelus
Cnemidophorus bilobatus

1941c Extinct toads and salamanders from Middle Pliocene beds of Wallace and Sherman counties, Kansas. Univ. Kansas Publ., State Geol. Surv. Kansas, Bull. No. 38, 1941. Reports of Studies, part 6, July 7, 1941, pp. 177-196, figs. 1-7.

Describes the following:

Scaphiopus antiquus
LANEBATRACHUS
Lanebatrachus martini
OGALLALABATRACHUS
Ogallalabatrachus horarium

1941d A new plethodont salamander from New Mexico. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 77-80.

Describes: *Plethodon hardii.*

1941e Two new species of Mexican plethodontid salamanders. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 81-86.

Describes: *Bolitoglossa melanomolge* and *Bolitoglossa galeanae.*

1941f Some Mexican frogs. Proc. Biol. Soc. Washington, Vol. 54, July 31, 1941, pp. 87-94.

Type descriptions of the following:

Microbatrachylus lineatissimus
Eleutherodactylus saltator
Eleutherodactylus occidentalis (*nov. nom.*)

1941g Smith, Hobart M. with Taylor, Edward H. *A review of the snakes of the genus* Ficimia. Journ. Washington Acad. Sci. Vol. 31, No. 8, Aug. 15, 1941, pp. 356-368, 1 plate, (fig.), figs. 1-16, Map fig. 17.

Ficimia ruspator is described.

1941h Two new ambystomid salamanders from Chihuahua. Copeia, 1941, No. 3, Sept. 30, pp. 143-146, figs. 1-2.

Ambystoma rosaceum and *Ambystoma fluvinatum* are described.

1941i A new Anuran from the Middle Miocene of Nevada. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 4, 1941 (Dec.) pp. 61-69, pl. I; text fig. 1.

Describes the genus *Miopelodytes* and *Miopelodytes gilmorei.*

1941j Herpetological miscellany No. II. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 7, 1941 (Dec.), pp. 105-139, pls. III-VI; text figs. 1-7.

The following are described:

Thorius dubitus
Thorius troglodytes
Bolitoglossa chondrostega
Bolitoglossa terrestris
Hyla arboricola
Geophis maculifera
Oxybelis potosiensis
Crotalus triseriatus gloydi

1941k New amphibians from the Hobart M. Smith Mexican collections. Univ. Kansas Sci. Bull., Vol. XXVII, pt. 1, No. 8, 1941 (Dec), pp. 141-167, pl. VII-XI; text figs. 1, A-C.

Describes the following new forms:

Bolitoglossa nigromaculata
Bolitoglossa occidentalis
Bolitoglossa xolocalcae
Bolitoglossa nigroflavescens
Eleutherodactylus matudae
Eleutherodactylus dorsoconcolor

1942a Tadpoles of Mexican anura. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 3, May 15, 1942, pp. 37-55, pls. I-III.

1942b The frog genus Diaglena, with a description of a new species. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 4, May 15, 1942, pp. 57-65, pls. IV, V.

Describes: *Diaglena reticulata.*

1942c New tailless amphibia from Mexico. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 5, May 15, 1942, pp. 67-89, pls. VI-IX.

The following species are described:

Microbatrachylus montanus
Microbatrachylus imitator
Eleutherodactylus macdougalli
Centrolenella viridissima
Hyla rozellae

1942d Some geckoes of the genus Phyllodactylus. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. 1, No. 6, May 15, 1942, pp. 91-112, text figs. 1-6.

Describes:

Phyllodactylus magnus
Phyllodactylus bordai
Phyllodactylus darwini

1942e Mexican snakes of the genera *Adelophis* and *Storeria*. Herpetologica, Vol. 2, No. 4, July 15, 1942, pp. 75-79.

Describes: *Storeria hidalgoensis*.

1942f "Island" Faunas on the Mexican plateau. Proc. Eighth American Scientific Congress, Vol. 3, Aug., 1942, pp. 503-504.

1942g. Extinct toads and frogs from the Upper Pliocene deposits of Meade County, Kansas. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 10, Nov. 15, 1942, pp. 199-235; pls. XIV-XX.

Describes:

Scaphiopus diversus
NEOSCAPHIOPUS
Neoscaphiopus noblei
ANCHYLORANA
Anchlorana moorei
Anchylorana dubita
Anchylorana robustocondyla
Rana fayeae
Rana meadensis
Rana ephippium
Rana rexroadensis
Rana valida
Rana parvissima

1942h [with Smith, Hobart M.] Concerning the snake genus Pseudoficimia. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II., No. 12, Nov. 15, 1942, pp. 241-251, pl. XXI; text figs. 1-4.

Pseudoficimia pulcherrima described.

1942i New Caudata and Salientia from Mexico. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II., No. 14, Nov. 15, 1932, pp. 295-323 pls. XXV-XXIX.

The following species are described:

Eleutherodactylus bolivari
Eleutherodactylus decoratus
Eleutherodactylus hidalgoensis
Syrrhophus modestus
Hyla beltrani
Hyla pachyderma
Rana megapoda
Bolitoglossa lavae

1942j [with Smith, Hobart M.] The snake genera, *Conopsis* and *Toluca*. Univ. Kansas Sci. Bull., Vol. XXVIII, pt. II, No. 15, Nov. 15, 1942, pp. 325-363; pls. XXX-XXV; text figs. 1-2.

Describes the following forms:

Conopsis biserialis
Toluca megalodon
Toluca conica

1943a [with Hesse, C. J.] A new salamander from the upper Miocene beds of San Jacinto County, Texas. Amer. Journ. Sci., Vol. 241, March 1943, pp. 185-193, fig. 1.

Describes: *Batrachosauroides* and *Batrachosauroides dissimulans*.

1943b A new Hylella from Mexico. Proc. Biol. Soc. Washington, Vol. 56, June 16, 1943, pp. 49-52.

Describes: *Hylella azteca*.

1943c A new ambystomid salamander adapted to brackish water. Copeia, 1943, No. 3, Oct. 15, pp. 151-156, text figs. 1-3.

Describes: *Ambystoma subsalsum*.

1943d An extinct turtle of the genus *Emys* from the Pleistocene of Kansas. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 3, Oct. 15, 1943, pp. 249-254, pl. XX.

Describes: *Emys twentei*.

1943e The Mexican lizards of the genus *Eumeces* with comments on the recent literature of the genus. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 5, Oct. 15, 1943, pp. 269-300.

1943f [with Smith, Hobart M.] A review of the American Sibynophine Snakes with a proposal of a new genus. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 6, Oct. 15, 1943, pp. 301-338, pls. XXI-XXV; text figs. 1-9.

Describes:

Scaphiodontophis
Scaphiodontophis albonuchalis
Scaphiodontophus cyclurus
Scaphiodontophis nothus
Scaphiodontophis carpicinctus

1943g Skin shedding in the salamander *Amphiuma means*. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 7, 1943, pp. 339-341.

1943h Herpetological novelties from Mexico. Univ. Kansas Sci. Bull., Vol. XXIX, pt. II, No. 8, Oct. 15, 1943, pp. 343-361, pls. XXVI-XXVII.

Describes:

Rhyacosiredon leorae
Bolitoglossa cochranae
Bufo nayaritensis
Bufo perplexus
Syrrhophus nebulosus
Tomodactylus albolabris
Microhyla mazatlanensis

1944a A new genus and species of Mexican frogs. Univ. Kansas Sci. Bull., Vol. XXX, pt. I, No. 3.

Describes: *Ptychohyla*, and the genotype *Ptychohyla adipoventris*.

1944b Two new species of crotalid snakes from Mexico. Univ. Kansas Sci. Bull., Vol. XXX, No. 4.

Describes: *Crotalus semicornutus* and *Crotalus transversus*.

1944c A new ambystomid salamander from the plateau region of Mexico. Univ. Kansas Sci. Bull., Vol. XXX, pt. 1, No. 5.

Describes: *Ambystoma granulosum*.

1944d The hylid genus *Acrodytes*, with comments on Mexican forms. Univ. Kansas Sci. Bull., Vol. XXX, pt. 1, No. 6.

Describes: *Acrodytes inflata*.

1944e Present location of certain herpetological and other types. Univ. Kansas Sci. Bull., Vol. XXX, No. 1, pp. 117-187.

1944f The genera of Mexican plethodontid salamanders. Univ. Kansas Sci. Bull., Vol. XXX, No. 1, pp. 189-232.

1944g [Hobart M. Smith] and ————————. Check list and key to the snakes of Mexico. In press.

1944h ———————— with Hobart M. Smith. Summary of the Collections of Amphibians made in Mexico under the Walter Rathbone Bacon Scholarship. In press.

Describes:

Ambystoma lacustris
Rhyacosiredon zempoalaensis
Pseudoeurycea cephalica rubrimembris
Bufo angustipes
Syrrhophus rubrimaculata
Eleutherodactylus avocalis
Eleutherodactylus conspicuus
Acrodytes modesta

1944i Hobart M. Smith with ————————. Checklist and key to the Amphibians of Mexico. In press.

FIRST SUPPLEMENT

List of Type Specimens in the EHT-HMS Collection

(Described by various authors)

AMPHIBIA

CAUDATA

OEDIPUS BROMELIACIA Schmidt. Paratype.

Paratypes. EHT-HMS, Nos. 27289-27290, topotypes. [Exc. Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 159-161, fig. 18.

Type loc. Volcan Tajumulco, 8,000 ft., above El Porvenir, San Marcos, Guatemala.

OEDIPUS DUNNI Schmidt. Paratype.

Paratypes. EHT-HMS, Nos. 27278-27279, topotypes. [Exc. Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 20, 1933, pp. 16-17.

Type loc. Mts. W. San Pedro, Honduras.

OEDIPUS ENGLEHARDTI Schmidt. Paratype.

Paratypes. EHT-HMS, Nos. 27275-27277, topotypes. [Exc. Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 156-157, fig. 18.

Type loc. Volcan Atitlan, 7,000 ft. above Olas de Moca, Solola, Guatemala.

OEDIPUS FLAVIMEMBRIS Schmidt. Paratype.

Paratype. EHT-HMS, No. 27272, topotype. [Exc. Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 158-159, fig. 17.

Type loc. Volcan Tajumulco, 7,200, on trail above El Porvenir, San Marcos, Guatemala.

OEDIPUS FRANKLINI Schmidt. Paratype.

Paratypes. EHT-HMS, Nos. 27273-27274, Volcan Atitlan, 7,000 ft., Guatemala (above Olas de Moca). [Ex Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 159-161, fig. 19.

Type loc. Volcan Tajumulco, 5,600 ft. elev. on trail above El Porvenir, San Marcos, Guatemala.

OEDIPUS GOEBELI Schmidt. Paratype.

Paratypes. EHT-HMS, Nos. 29878-29879, topotypes. [Exc. Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 163-164, fig. 17.

Type loc. Volcan Tajumulco, 8,000 ft., on trail above El Porvenir, San Marcos, Guatemala.

OEDIPUS HELMRICHI Schmidt. Paratype.

Paratype. EHT-HMS, No. 27073, topotype. [Exc. Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 20, No. 17, Oct. 31, 1936, pp. 152-154, fig. 18.

Type loc. Mountains above Finca Samac, west of Coban, Alta Verapaz, Guatemala, 5,000 ft.

OEDIPUS NASALIS Dunn. Paratype.

Paratypes. EHT-HMS, Nos. 27286-27287. [Exc. Field Mus.]

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 12, 1924, p. 97.

Type loc. Mountains above San Pedro, Honduras.

OEDIPUS TOWNSENDI Dunn. Paratype.

Paratype. EHT-HMS, No. 26562, topotype. [Exc. M. C. Z. Harvard Coll.]

Publ. Proc. Biol. Soc. Washington, 35, 1922, p. 5.

Type loc. Cerro de los Estropajos, near Jalapa, Veracruz.

SALIENTIA

ATELOPUS SPURRELLI CERTUS Barbour. Paratype.

Paratypes. EHT-HMS, Nos. 29859, 29859A, topotypes. Exc. M. C. Z. Harvard College.

Publ. Occ. Papers Mus. Zoöl. Univ. Michigan No. 129, 1923, pp. 15-21.

Type loc. Mt. Sapo, eastern Panamá Republic.

CHAPERINA PUNCTATA van Kampen. Cotype.

Cotype. EHT-HMS, No. 29862, Heuvelbivak, 800 m. "Went-gebirge" south New Guinea. [Exc. Zoöl. Mus. Amsterdam.]

Publ. Nova Guinea. Résultats de l'expédition Scientifique néerlandaise à la Nouvelle-Guinée, Vol. IX, Zoologie, Liv. 3, 1913, pp. 463-464, pl. XI, fig. 7.

Type loc. Went Mts. and Helwig Mts., south New Guinea.

CORNUFER BEAUFORTI van Kampen = (?) RANA BEAUFORTI (van Kampen). Cotype.

Cotype. EHT-HMS, No. 29864, Waigeu. [Exc. Zoöl. Mus. Amsterdam.]

Publ. Bijdr. t. d. Dierk, pt. 19, 1913, p. 91.

Type loc. Waigeu I., East Indian Archipelago.

DENDROBATES MINUTUS VENTRIMACULATUS Shreve. Paratype.

Paratype. EHT-HMS, No. 29860, Pastaza river, Conelos to Maranon, Ecuador. [Exc. M. C. Z. Harvard Coll.]

Publ. Occ. Papers Boston Soc. Nat. Hist., 8, July 30, 1935, pp. 209-218.

Type loc. Sarayacu, Ecuador.

ELEUTHERODACTYLUS PARVUS Barbour and Shreve. Paratype.

Paratype. EHT-HMS, No. 29858, topotype. [Exc. M. C. Z. Harvard Coll.]

Publ. Bull. Mus. Comp. Zoöl. Harvard Coll., 80, No. 9, 1937, pp. 386-387, pl. 2, figs. 3-4.

Type loc. Cueva del Aura, Turquino peak, circa 3,500 ft., Oriente, Cuba.

ELEUTHERODACTYLUS TALAMANCAE Dunn. Paratype.

Paratypes. EHT-HMS, Nos. 29873-29874, La Loma, Panamá. [Exc. M. C. Z. Harvard Coll.]

Publ. Occ. Papers Boston Soc. Nat. Hist., 5, 1931, p. 385.

Type loc. Almirante, Panamá.

ELEUTHERODACTYLUS TURQUINENSIS Barbour and Shreve. Paratype.

Paratype. EHT-HMS, No. 29880, topotype. [Exc. M. C. Z. Harvard Coll.]

Publ. Bull. Mus. Comp. Zoöl. Harvard Coll., 80, No. 9, Sept., 1937, pp. 380-382, pl. 3, fig. 1.

Type loc. Cueva del Aura, Turquino Peak, Oriente, Cuba.

ELEUTHERODACTYLUS SPATULATUS Smith. Paratype.

Paratypes. EHT-HMS, Nos. 18826 (S. 4474), 18830 (S. 4478).

Publ. Proc. Biol. Soc. Washington, 52, Dec. 15, 1939, pp. 187-190, pl. II, figs. 4-5.

Type loc. Cuautlapan, Veracruz, México. *Coll.,* H. M. Smith, Jan. 5, 1939.

GASTROTHECA BOLIVIANA GRISWOLDI Shreve. Paratype.

Paratypes. EHT-HMS, Nos. 29871-29872, topotypes. [Exc. M. C. Z. Harvard Coll.]

Publ. Proc. New England Zoöl. Club, 18, Sept. 13, 1941, pp. 71-83.

Type loc. Marayníoc, 72 km. N.E. Tarma (12,000 ft.), Dept. Junin, Perú.

HYLA LOQUAX Gaige. Paratype.

Paratype. EHT-HMS, No. 29842, topotype. [Exc. Mus. Zoöl. Univ. Michigan.]

Publ. Occ. Papers Mus. Zoöl., Univ. Michigan, No. 281, June 9, 1934, pp. 1-3.

Type loc. Ixpuc Aguada, north of La Libertad, El Petén, Guatemala.

HYLA PARKERI Gaige. Paratype.

Paratypes. EHT-HMS, Nos. 29867-29868, topotypes. [Exc. Michigan Mus. Zoöl.]

Publ. Occ. Papers Mus. Zoöl., Univ. Michigan, No. 207, Sept. 28, 1929, pp. 1-3.

Type loc. Buenavista, Dept. Santa Cruz, Bolivia, S. A.

HYLA SANGUINOLENTA van Kampen. Cotype.

Cotype. EHT-HMS, No. 29866, Lorentz River (Noord-fluss), south New Guinea. [Exc. Zoöl. Mus. Amsterdam.]

Publ. Nova Guinea Résultats de l'Expédition Scientifique néerlandaise à la Nouvelle-Guinée, Vol. IX, Zoologie, 1909, pp. 33-34, pl. II, fig. 3.

Type loc. "Noord-Fluss bei Bivac Insel; Noord-Fluss; Noord-Fluss bei Sabang," south New Guinea. *Coll.,* Lorentz Expedition, 1907.

HYLOXALUS PANAMANSIS (sic) Dunn. Paratype.

Paratype. EHT-HMS, No. 29729, topotype. [Exc. M. C. Z. Harvard Coll.]

Publ. Occ. Papers Boston Soc. Nat. Hist., 8, June 7, 1933, pp. 69-71.

Type loc. El Valle de Anton, Province of Panamá.

PELOPHRYNE ALBOTAENIATA Barbour. Paratype.

[Paratype.] EHT-HMS, No. 29845, Thumb Peak, Palawan, P. I. Topotype [not designated as paratype but collected at same spot, the same day (Oct. 17, 1923)].

Publ. Proc. Biol. Soc. Washington, 51, Nov. 3, 1938, pp. 194-195, fig.

Type loc. Elevation, 4,500 ft., Thumb Peak, Palawan, P. I.

PHANEROTIS NOVAE-GUINEA van Kampen. Cotype.

Cotype. EHT-HMS, No. 29861, Merauke, south New Guinea. [Exc. Zoöl. Mus. Amsterdam.]

Publ. Nova Guinea. Résultats de l'expédition Scientifique néerlandaise à la Nouvelle-Guinée, Vol. IX, 1919, p. 36, pl. 2, fig. 4.

Type loc. Merauke, south New Guinea.

PHYLLOBATES FLOTATOR Dunn. Paratype.

Paratypes. EHT-HMS, Nos. 29726, 29727, 29736, topotypes. [Exc. M. C. Z. Harvard Coll.]

Publ. Occ. Papers Boston Soc. Nat. Hist., 5, 1931, p. 389.

Type loc. Barro Colorado I, Canal Zone.

RANA KOHCHANGAE M. Smith. Cotype.

Cotype. EHT-HMS, No. 29884, topotype. [Exc. Malcolm Smith.]

Publ. Journ. Nat. Hist. Siam, IV, No. 4, July 25, 1922, pp. 223-225.

Type loc. Koh Chang I. (Chang I.), Inner Gulf of Siam.

RANA MICROTYMPANUM van Kampen. Cotype.

Cotype. EHT-HMS, No. 29865, Loka, near Bonthain, Celebes (one of 6 cotypes). [Exc. Zoöl. Mus. Amsterdam.]

Publ. Zoöl. Ergebnisse einer reise in Niederlandisch Ost-Indien herausgegeben von Dr. Max Weber, Bd. IV, Heft. 2, 1907, pp. 386-388, pl. XVI, fig. 2.

Type loc. Loka bei Bonthain, Celebes. *Coll.,* M. Weber.

RANA MILLETTI M. Smith. Cotype.

Cotype. EHT-HMS, No. 29886, Langbian, South Annam. [Exc. Malcolm Smith.]

Publ. Proc. Zoöl. Soc. London, 1921 (June), pp. 432-433, pl. II, fig. 2.

Type loc. Dalat, South Annam.

RANA MONTIVAGA M. Smith. Cotype.

Cotype. EHT-HMS, No. 29885, Langbian Plateau, south Annam. [Exc. Malcolm Smith.]

Publ. Proc. Zoöl. Soc. London, 1921 (June), pp. 436-437, pl. I, fig. 2.

Type loc. Dalat, Langbian Plateau, south Annam.

SYRRHOPUS (sic) CARYOPHYLLACEUS Barbour [= *Eleutherodactylus caryophyllaceus* (Barbour)]. Paratype.

Paratypes. EHT-HMS, Nos. 29869-29870, topotypes. [Exc. M. C. Z., Harvard Coll.]

Publ. Proc. New England Zoöl. Club, 10, Mar. 2, 1928, p. 28, pl. 2, fig. 1.

Type loc. La Loma, W. Panamá.

SYRRHOPUS (sic) JUNINENSIS Shreve. Paratype.

Paratype. EHT-HMS, No. 29866, topotype. [Exc. M. C. Z., Harvard Coll.]

Publ. Journ. Washington Acad. Sci., 28, No. 9, Sept. 15, 1938, pp. 406-407.

Type loc. Cascas, near Huasahuasi, Dept. Junin, Perú.

XENORHINA OCELLATA van Kampen. Cotype.

Cotype. EHT-HMS, No. 29863, Hellwig Mts., south New Guinea (one of three cotypes). [Exc. Zoöl. Mus. Amsterdam.]

Publ. Nova Guinea. Résultats de l'Expédition scientifique néerlandaise à la Nouvelle-Guinée, Vol. IX, Zoologie, Liv. 3, 1913, p. 461, pl. XI, figs. 4, 5.

Type loc. Hellwig Mts., about 2,500 m., south New Guinea. *Coll.,* van Kampen.

REPTILIA

LACERTILIA

ANOLIS DUNNI Smith. Holotype.

Type. EHT-HMS, No. 11129. Orig. EHT-HMS Field No. 1506.

Publ. Copeia, 1936, No. 1 (May 10), p. 9.

Type loc. Between Rincón and Cajones [near Agua del Obispo], Guerrero, México. *Coll.*, E. H. Taylor, July 1, 1932.

ANOLIS MEGAPHOLIDOTUS Smith. Holotype.

Type. EHT-HMS, No. 11149. Orig. EHT-HMS Field No. 1500. *Paratypes.* EHS-HMS Nos. 11141-11144, topotypes.

Publ. Trans. Kansas Acad. Sci., 36, 1933, pp. 318-320.

Type loc. Between Rincón and Cajones [Agua del Obispo], Guerrero, México. *Colls.*, H. M. Smith and E. H. Taylor, July 1, 1932.

GERRHONOTUS LEVICOLLIS CILIARIS Smith. Paratype.

Paratypes. EHT-HMS, Nos. 10418-10421, San Felipe, Guanajuato, México.

Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 365-367.

Type loc. Sierra Guadelupe, Coahuila, México.

LEIOLOPISMA ASSATUM TAYLORI Oliver. Paratype.

Paratypes. EHT-HMS, Nos. 10057-10058, km. 350, Agua del Obispo, Guerrero; Nos. 10048, near Mazatlán, 12 mi. S. Chilpancingo, Guerrero.

Publ. Occ. Papers Mus. Zoöl. Univ. Michigan, No. 360, Nov. 20, 1927.

Type loc. Santiago, Colima, México.

LEPIDOBLEPHARIS BARBOURI Noble. Paratype.

Paratype. EHT-HMS, No. 29737-29738, Bella Vista, N. W. Perú. [Exc. M. C. Z. Harvard Coll.]

Publ. ———.

Type loc. ———.

LEPIDOPHYMA SMITHII TEHUANAE Smith. Paratype.

Paratype. EHT-HMS, No. 28136, Tres Cruces, Oaxaca, México.

Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 377-378.

Type loc. Cerro Arenal, 30 km. W. Tehuantepec, Oaxaca.

LYGOSOMA CHERRIEI STUARTI Smith. Paratype.

Paratype. EHT-HMS, No. 29881 (HMS, No. 1780), Potrero Viejo, Veracruz, México.

Publ. Proc. Biol. Soc. Washington, 54, Dec. 8, 1941, p. 181.

Type loc. Potrero Viejo, Veracruz, México.

PHYLLODACTYLUS HOMOLEPIDURUS Smith. Holotype.

Type. EHT-HMS, No. 10853. Originally Field No. 146. *Paratypes.* EHT-HMS, Nos. 10849-10850, topotypes; Nos. 10851-10852; 10854-10874, Guaymas and La Posa; Nos. 10875-10876, betweeen Empalme and Guaymas, Sonora.

Publ. Univ. Kansas Sci. Bull., XXII, No. 6, 1935 (Nov. 15), pp. 121-125, pl. XXV, fig. 2; text fig. 1A.

Type loc. Five mi. S.W. Hermosillo, Sonora, México. *Coll.*, Edward H. Taylor, June 22, 1934.

PHYLLODACTYLUS LANEI Smith. Holotype.

Type. EHT-HMS, No. 10942. Originally EHT-HMS, Field No. 1461. *Paratypes.* EHT-HMS, No. 11015-11022, 1 mi. N. Organos, Gro.; 11023-11034, Tierra Colorado, Gro.

Publ. Univ. Kansas Sci. Bull., Vol. XXII, No. 6, 1935 (Nov. 15), pp. 125-132, pl. XXV, fig. 3, text fig. 1B.

Type loc. Near Tierra Colorada, Guerrero, México. *Colls.,* Edward H. Taylor and Hobart M. Smith, June 30, 1932.

[Certain of the original series of paratypes have been referred to *Phyllodactylus magna* Taylor.]

PHYLLODACTYLUS MAGISTER Noble. Paratype.

Paratypes. EHT-HMS, Nos. 29739-29740, topotypes. [Exc. M. C. Z. Harvard Coll.]

Publ. Occ. Papers Boston Soc. Nat. Hist., 5, 1924, p. 110.

Type loc. Perico, Chinchipe R., Perú.

SCELOPORUS AENEUS BICANTHALIS Smith. Holotype.

Type. Field Mus., No. ———. Orig. EHT-HMS, No. 7939. *Paratypes.* EHT-HMS, Nos. 7919, 7933, 7935, topotypes.

Publ. Occ. Pap. Mus. Zoöl., Univ. Mich., No. 361, Dec. 15, 1937, pp. 6-8.

Type loc. Cofre de Perote, near Cruz Blanca, Veracruz, México. *Coll.,* Edward H. Taylor.

SCELOPORUS CAUTUS Smith. Holotype.

Type. Field Mus., No. ———. [Orig. EHT-HMS, No. 13027.] *Paratypes.* EHT-HMS, Nos. 13025, 30 mi. N. Matehuala S. L. P.: Nos. 13051, 53, La Colorada, Zac.; 13055, 57, 59, 61, 10 mi. S. Majoma, Zac.

Publ. Occ. Pap. Mus. Zoöl., Univ. Michigan, No. 387, Oct. 31, 1938, pp. 2-7.

Type loc. Thirty mi. N. El Salado (San Luis Potosí) in the state of Coahuila, México. *Colls.,* E. H. Taylor and Hobart M. Smith, Aug. 21, 1932.

SCELOPORUS CARINATUS Smith. Holotype.

Type. Field Mus., No. ———. Orig. EHT-HMS, Field No. 4866.

Publ. Proc. Biol. Soc. Washington, 49, July 3, 1936, pp. 89-92, pl. II, figs. 2, 3.

Type loc. Near Tuxtla Gutierrez, Chiapas, México. *Colls.,* E. H. Taylor and Hobart M. Smith, Sept. 4, 1935.

SCELOPORUS EDWARDTAYLORI Smith. Holotype.

Type. EHT-HMS, No. 8331. [Orig. EHT-HMS, No. 4221.] *Paratypes.* 8311, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, Totolapam, Oaxaca; 8333, topotype.

Publ. Herpetologica, Vol. 1, 1936, pp. 6-8.

Type loc. Near Ixtepec (San Gerónimo), Oaxaca, México. *Colls.,* E. H. Taylor and H. M. Smith, Aug. 7, 1935.

SCELOPORUS FORMOSUS SCITULUS Smith. Holotype.

Type. EHT-HMS, No. 26962. *Paratypes.* EHT-HMS, Nos. 26956-26961; 26963-26975.

Publ. Proc. U. S. Nat. Mus., 92, 1942 (No. 3153), pp. 352-354.

Type loc. Omilteme, Guerrero [about 4 mi. E.]. *Coll.,* E. H. Taylor, Aug. 2-4, 1940. [Richard C. Taylor did not collect at Omilteme.]

SCELOPORUS HORRIDUS ALBIVENTRIS Smith. Holotype.

Type. EHT-HMS, No. 8519. *Paratypes.* 8511A, B, 13, 15, 17, topotypes.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 26, July 21, 1939, pp. 108-110.
Type loc. Tepic, Nayarit, México.

SCELOPORUS JARROVII IMMUCRONATUS Smith. Holotype.

Type. EHT-HMS, No. 9358A. [Orig. EHT-HMS, Field No. 500.] EHT-HMS, Nos. 5357-9367 (uneven numbers only), topotypes. 9368-9378, uneven numbers only, 25 mi. S. Jacala, Hgo.
Publ. Copeia, 1936 (Dec. 31), pp. 223-227.
Type loc. Ten mi. N. El Pinalito, Hidalgo, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, June 15, 1932.

SCELOPORUS JARROVII OBERON Smith and Brown. Paratype.

Paratypes. EHT-HMS, Nos. 26916-26939, Mt. Zapalinamé, near Saltillo, Coahuila, México.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 24, No. 23, Aug. 30, 1941, pp. 253-257, fig. 24.
Type loc. Arteaga, Coahuila, México.

SCELOPORUS JARROVII SUGILLATUS Smith. Paratype.

Paratypes. EHT-HMS, Nos. 22311-22321.
Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 357-359.
Type loc. Lake No. 4, Zempoala, México, México.

SCELOPORUS LINEOLATERALIS Smith. Holotype.

Type. Field Mus., No. —. Orig. EHT-HMS, Field No. 4323. *Paratypes.* Uneven numbers, EHT-HMS, between 9380-9404.
Publ. Proc. Biol. Soc. Washington, 49, July 3, 1936, pp. 92-95.
Type loc. Six miles N.E. Pedriceña, Durango, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, Aug. 27, 1932.

SCELOPORUS LUNDELLI GAIGEAE Smith. Paratype.

Paratype. EHT-HMS, No. 9943, topotype.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 26, July 27, 1939, pp. 71-74.
Type loc. Mérida, Yucatán, México.

SCELOPORUS LUNDELLI LUNDELLI Smith. Paratype.

Paratypes. EHT-HMS, Nos. 9945, 47, 49, 51, 53, 55, Balchacaj, Campeche.
Publ. Zoöl. Ser. Field Mus. Nat. Hist., 26, July 27, 1939, pp. 66-71.
Type loc. Cohune Ridge (20 mi. S.E. Benque Viejo), British Honduras.

SCELOPORUS MACULOSUS Smith. Holotype.

Type. Field Mus., No. —. [Orig. EHT-HMS, Field No. 4483.] *Paratypes.* EHT-HMS, Nos. 7643, 6 mi. N.E. Pedriceña; 7645, 7647, 14 mi. N.E. Pedriceña.
Publ. Trans. Kansas Acad. Sci., Vol. 37, 1934, pp. 267-269, pl. VIII, figs. 2, 4, 5; pl. X, fig. 11.
Type loc. Fourteen mi. N.E. Pedriceña, Durango, México. *Colls.*, Edward H. Taylor and Hobart M. Smith, Aug. 29, 1932.

SCELOPORUS MEGALEPIDURUS Smith. Holotype.

Type. EHT-HMS, No. 7543. Orig. EHT-HMS, Field No. 2908. *Paratypes.* EHT-HMS, uneven numbers between 7500-7610.

Publ. Trans. Kansas Acad. Sci., 37, 1934, pp. 272, 274-277, pl. IX, figs. 7, 8; pl. X, fig. 13.

Type loc. Near Totalco, Veracruz, México. *Colls.,* Edward H. Taylor and Hobart M. Smith, July 19, 1932.

SCELOPORUS MELANORHINUS CALLIGASTER Smith. Paratype.

Paratypes. EHT-HMS, Nos. 8267, 8269, Queseria, Colima; Nos. 8271, 73, 73A, 75, 77, Hda. Paso del Río, Colima; Nos. 8279, 82, 83, 85, 87, 89, 91, 93, 97, 99, Hda. El Sabino, Michoacán; Nos. 8301, 03, 05, 07, 09, El Treinte, Guerrero.

Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 360-361, fig. 38.

Type loc. Acapulco, Guerrero, México.

SCELOPORUS MERRIAMI ANNULATUS Smith. Holotype.

Type. EHT-HMS, No. 29882. [Orig. EHT, A 787.]

Publ. Proc. Biol. Soc. Washington, 50, June 22, 1937, pp. 83-86.

Type loc. East slope Chisos Mts., Brewster County, Texas, U. S. A. *Colls.,* Edward H. Taylor and John Suarez Wright.

SCELOPORUS MUCRONATUS AUREOLUS Smith. Paratype.

Paratypes. EHT-HMS, uneven numbers between 9189-9216. [Formerly EHT-HMS, Field Nos. 3073-3080, 3082, 3102, 3171-3174, 3193-3195.] Topotypes.

Publ. Proc. U. S. Nat. Mus., 92, No. 3153, 1942, pp. 356-357.

Type loc. Two mi. W. Acultzingo, Veracruz, México.

SCELOPORUS OCHOTERENAE Smith. Holotype.

Type. EHT-HMS, No. 7158. [Orig. EHT-HMS, Field No. 1075.] *Paratypes* (37), all uneven numbers between 7135-7207. Various localities in Guerrero, México.

Publ. Trans. Kansas Acad. Sci., 37, 1934, pp. 267-269, pl. IX, figs. 6, 9; pl. X, fig. 12.

Type loc. Two mi. N. Mazatlán (12 mi. S. Chilpancingo), Guerrero, México. *Colls.,* Edward H. Taylor and Hobart M. Smith.

SCELOPORUS OLIVACEUS Smith. Holotype.

Type. EHT-HMS, No. 29883. [Orig. EHT, Field No. 2508.]

Publ. Trans. Kansas Acad. Sci., 37, 1935, pp. 277-279.

Type loc. Arroyo Los Olmos, 3 mi. S.E. Rio Grande City, Texas. *Colls.,* E. H. Taylor and John S. Wright, Aug. 23, 1931.

SCELOPORUS PARVUS Smith. Holotype.

Type. EHT-HMS, No. 7120. [Orig. EHT-HMS, Field No. 292.] *Paratypes.* EHT-HMS, 7119-21, 23, 25, 31, 33.

Publ. Trans. Kansas Acad. Sci., Vol. 37, 1934, pp. 263-267, pl. VIII, figs. 1, 3; pl. X, fig. 10.

Type loc. Five mi. W. Sabinas Hidalgo, Nuevo León, México. *Colls.,* Edward H. Taylor and Hobart M. Smith, June 8, 1932.

SCELOPORUS PARVUS SCUTULATUS Smith. Holotype.

Type. EHT-HMS, No. 7129. *Paratype.* EHT-HMS, No. 7127, topotype.

Publ. Occ. Pap. Mus. Zoöl., Univ. Michigan, No. 358, Oct. 30, 1937, pp. 4-6.

Type loc. Thirty mi. N. Matahuala, San Luis Potosí, México. *Colls.,* E. H. Taylor and H. M. Smith, Aug. 20, 1932.

SCELOPORUS SCALARIS UNICANTHALIS Smith. Holotype.

Type. EHT-HMS, No. 7699.

Publ. Occ. Papers Mus. Zoöl., Univ. Michigan, No. 361, Dec. 15, 1937, pp. 4-5.

Type loc. Magdalena, Jalisco, México. *Coll.,* Hobart M. Smith, June 30, 1935.

SCELOPORUS SERRIFER PLIOPORUS Smith. Paratype.

Paratypes. EHT-HMS, Nos. 9417, topotype; 9409, 11, 13, 15, 5 mi. E. Jalapa, Veracruz; 9405, 9407, Las Vigas, Veracruz.

Publ. Zoöl. Ser. Field Mus. Nat. Hist., 26, 1939, pp. 212-213.

Type loc. Four mi. E. Encero, Veracruz, México.

SCELOPORUS SPINOSUS CAERULEOPUNCTATUS Smith. Paratype.

Type. Field Mus., No. ———. [Orig. EHT-HMS, No. 8467.] *Paratype.* EHT-HMS, No. 8465, topotype.

Publ. Univ. Kansas Sci. Bull., Vol. XXIV, No. 18, 1936 (Feb. 16, 1938), pp. 471-473.

Type loc. Slopes of Cerro San Luís, about 15 mi. N. Oaxaca, Oaxaca, México. *Coll.,* Hobart M. Smith, Aug. 5, 1935.

SCELOPORUS STEJNEGERI Smith. Paratype.

Type. EHT-HMS, Nos. 22285-22287; 27299-27301; topotypes.

Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 350-352.

Type loc. Tierra Colorada, Guerrero, México.

SCELOPORUS VARIABILIS SMITHI Hartweg and Oliver. Paratype.

Paratype. EHT-HMS, Nos. 7875, 7877, topotypes.

Publ. Occ. Papers Mus. Zoöl. Univ. Michigan, No. 356, 1937, pp. 1-5.

Type loc. Guengola Mountain, 6 km. N.W. Tehuantepec, Oaxaca, México.

TROPIDOPHORUS LAOTUS M. Smith = *Tropidophorus berdmorei laotus* (M. Smith). Cotypes.

Cotypes. EHT-HMS, Nos. 29887-29888, topotypes. Formerly M. Smith, Nos. 5443, 5571. [Exc. Malcolm Smith.]

Publ. Proc. Zoöl. Soc. London, Dec., 1923, pp. 777-778.

Type loc. Muang Liep, N. of Pak Lai, Upper Mekong, French Laos.

UTA TAYLORI Smith. Holotype.

Type. EHT-HMS, No. 10692. Originally EHT-HMS, Field No. 320a. *Paratypes.* 10689-10682, 54 mi. S.W. Hermosilla; 10683-10691A; 10693-10702, topotypes.

Publ. Univ. Kansas Sci. Bull., Vol. XXI, No. 7, 1935 (Nov. 15), pp. 158-166, pl. XXVI, fig. 3.

Type loc. Ten mi. M.W. Guaymas, Sonora, México. *Coll.,* E. H. Taylor, July 3, 1934.

SERPENTES

ADELPHICOS VERAEPACIS NIGRILATUS Smith. Holotype.

Type. EHT-HMS, No. 15335. *Paratypes.* Nos. 15331-4; 15336-42, all topotypes.

Publ. Proc. Rochester Acad. Sci., 8, Sept. 10, 1942, pp. 182-186, fig. 1.

Type loc. San Cristobal, Chiapas, México. *Coll.,* H. Devlin Thomas.

CLELIA CLELIA IMMACULATA Smith. Paratype.

Paratype. EHT-HMS, No. 4568, Paso del Río, Colima, México.

Publ. Proc. U. S. Nat. Mus., 92, 1942, p. 394.

Type loc. "Guadalajara," Jalisco, México.

CONIPHANES FISSIDENS DISPERSUS Smith. Holotype.

Type. EHT-HMS, No. 5531. *Paratype.* No. 5532, topotype.

Publ. Proc. U. S. Nat. Mus., 91, No. 3127, 1941, pp. 106-107.

Type loc. El Limoncito [near La Venta], Guerrero, México.

CROTALUS TRISERIATUS ANAHUACUS Gloyd. Paratype.

Paratypes. EHT-HMS, Nos. 5492, near Tres Cumbres (km. 43), D. F.; 5473-5474, Lake of Zampoala, Morelos, México.

Publ. The Rattlesnakes genera *Sistrurus* and *Crotalus,* Chicago Acad. Sci., Sp. Publ. No. 4, 1940, pp. 91-95.

Type loc. "Valley of México."

DENDROPHIDION VINITOR Smith. Paratype.

Paratypes. EHT-HMS, Nos. 27496-27498, La Gloria, Oaxaca, México.

Publ. Proc. Biol. Soc. Washington, 54, 1941, pp. 73-76,

Type loc. Piedras Negras, Petén, Guatemala.

DRYMARCHON CORAIS RUBIDUS Smith. Paratype.

Paratypes. EHT-HMS, No. 5405, Puente de Ixtla, Morelos [near Huajintlan, km. 133]; No. 5400, Magdalena, Jalisco; Nos. 5331, 5406, El Sabino, Michoacán; No. 5591, Huajintlán, Guerrero; No. 21514, Guerrero.

Publ. Journ. Washington Acad. Sci., 31, No. 11, Nov. 15, 1941, pp. 474-476.

Type loc. Rosario, Sinaloa, México.

DRYMARCHON CORAIS UNICOLOR Smith. Paratype.

Paratype. EHT-HMS, No. 29876 (HMS, 14556), topotype.

Publ. Journ. Washington Acad. Sci., 31, No. 11, Nov. 15, 1941, pp. 470-472.

Type loc. La Esperanza, near Escuintla, Chiapas, México.

DRYMOBIUS MARGARITIFERUS FISTULOSUS Smith. Paratype.

Paratypes. EHT-HMS, No. 4607, Paso del Río, Colima; Nos. 4708, 5363-5365, Hda. El Sabino, near Uruapan, Michoacán; No. 4613, Cuernavaca, Morelos; No. 5366, Ocotito, Guerrero; No. 23627, Tierra Colorada, Guerrero, México.

Publ. Proc. U. S. Nat. Mus., 92, 1942, pp. 383-384.

Type loc. Miramar, Nayarit, México.

LEPTODEIRA ANNULATA TAYLORI Smith. Paratype.

Paratype. EHT-HMS, No. 4618, Acultzingo, Veracruz, México.

Publ. Proc. Biol. Soc. Washington, 54, Sept. 30, 1941, pp. 115-117.

Type loc. Orizaba, Veracruz, México.

LEPTOTYPHLOPS BAKEWELLI Oliver. Paratype.

Paratype. EHT-HMS, No. 5477, topotype.

Publ. Occ. Papers Mus. Zoöl. Univ. Michigan, No. 36, Nov. 20, 1937, pp. 16-18, fig. 1.

Type loc. Paso del Río, Colima.

MASTICOPHIS FLAGELLUM LINEATULUS Smith. Paratype.

Paratype. EHT-HMS, No. 5388, between Torreon and San Pedro, Coahuila, México.

Publ. Journ. Washington Acad. Sci., 31, No. 9, Sept. 15, 1941, pp. 394-397.

Type loc. Eleven mi. S. San Buenaventura, Chihuahua, México.

MASTICOPHIS TAENIATUS AUSTRALIS Smith. Paratype.

Paratype. EHT-HMS, No. 26227, Tacícuaro, Michoacán, México.

Publ. Journ. Washington Acad. Sci., 31, No. 9, Sept. 15, 1941, pp. 390-392.

Type loc. "Guanajuato."

MICRURUS FITZINGERI MICROGALBINEUS Brown and Smith. Holotype.

Type. EHT-HMS, No. 27847. *Paratype.* EHT-HMS, No. 5515, 18 km. N. Valles, San Luis Potosí. *Coll.*, E. H. Taylor.

Publ. Proc. Biol. Soc. Washington, 55, June 25, 1942, pp. 63-66.

Type loc. Seven km. S. Antiguo Morelos, Tamaulipas, México. *Coll.*, Bryce C. Brown, June 21, 1942.

NINIA DIADEMATA PLORATOR Smith. Holotype.

Type. EHT-HMS, No. 23557.

Publ. Copeia, 1942, No. 3, Oct. 8, pp. 153-154.

Type loc. Durango, Hidalgo, México. *Coll.*, Radclyffe Roberts (not E. H. Taylor as stated in the type description, *loc. cit.*).

PLIOCERCUS ELAPOIDES LATICOLLARIS Smith. Paratype.

Paratypes. EHT-HMS, No. 11642, Tres Brazos, Campeche, and No. 11643, Encarnación, Campeche.

Publ. Proc. Biol. Soc. Washington, 54, Sept. 30, 1941, pp. 122-123.

Type loc. Chichen Itza, Yucatán, México.

PLIOCERCUS ELAPOIDES SCHMIDTI Smith. Paratype.

Paratypes. EHT-HMS, No. 11642, Tres Brazos, Campeche, and 11643, Encarnación, Campeche. [Orig. referred to *P. e. laticollaris* Smith.]

Publ. Proc. Biol. Soc. Washington, 55, Oct. 17, 1942, pp. 161-162.

Type loc. Chichen Itza, Yucatán, México.

RHADINAEA AEMULA Bailey. Paratype.

Paratypes. EHT-HMS, No. 5218, Tres Marias, Morelos; No. 5219, 10 km. N. Cuernavaca, Morelos, [elev., about 7,500 ft.].

Publ. Occ. Papers Mus. Zoöl. Univ. Michigan, No. 412, May 6, 1940, pp. 4-5, pl. 1, fig. 3.

Type loc. Omilteme and Sierra de Burro, Guerrero, México.

RHADINAEA CRASSA Smith. Holotype.

Type. EHT-HMS, No. 5526. *Paratype.* EHT-HMS, No. 23548.
Publ. Proc. Biol. Soc. Washington, 55, 1942, pp. 190-191, figs. 4, 5.
Type loc. Durango, Hidalgo, México.

RHADINAEA FORBESI Smith. Paratype.

Paratype. EHT-HMS, No. 23956, topotype. [Orig. HMS, No. 13211.]
Publ. Proc. Biol. Soc. Washington, 55, 1942, pp. 188-189.
Type loc. Tequeyutepec, 7 mi. W. Jalapa, Veracruz.

RHADINAEA HESPERIA Bailey. Paratype.

Paratypes. EHT-HMS, Nos. 5444, El Treinte, Guerrero. Nos. 5441-5442, Hacienda El Sabino, Michoacán.
Publ. Occ. Papers Mus. Zoöl. Univ. Michigan, No. 412, May 6, 1940, pp. 4-5, pl. 1, fig. 3.
Type loc. Omilteme and Sierra de Burro, Guerrero, México.

RHADINAEA HESPERIA BAILEYI Smith. Holotype.

Type. EHT-HMS, No. 5444.
Publ. Proc. Biol. Soc. Washington, 55, Dec. 31, 1942, pp. 187-188, fig. 2.
Type loc. El Treinte, Guerrero, México. *Coll.,* E. H. Taylor, Aug. 1, 1936.

RHADINELLA SCHISTOSA Smith. Genotype—Holotype.

Type. EHT-HMS, No. 23580. *Paratypes.* EHT-HMS, Nos. 23571, 23577-23579, 23581, topotypes.
Publ. Copeia, 1941, No. 1, March 25, pp. 7-10, fig. 1.
Type loc. Cuautlapan, Veracruz, México. *Coll.,* E. H. Taylor, Aug., 1940.

SALVADORA INTERMEDIA RICHARDI Smith. Holotype.

Type. EHT-HMS, No. 23470.
Publ. Smithsonian Misc. Coll. 99, No. 20, Feb. 21, 1941, pp. 6-9, fig. 5.
Type loc. One mile N. Tehuacán, Puebla, México. *Coll.,* Richard Clark Taylor, Aug. 8, 1940.

TANTILLA PHRENITICA Smith. Paratype.

Paratypes. EHT-HMS, No. 22367, El Limón (Totalco), Veracruz; EHT-HMS, Nos. 23561-70, 23572-76, 23582 (topotypes), Cuautlapan, Veracruz.
Publ. Zoologica, 27, No. 7, 1942, p. 39.
Type loc. Cuautlapan, Veracruz, México.

TANTILLA WILCOXI RUBRICATA Smith. Paratype.

Paratype. EHT-HMS, No. 23473, Mt. Zapalinamé, Saltillo, Coahuila, México.
Publ. Zoologica, 27, 7, 1942, pp. 40-41.
Type loc. Fifteen mi. S.E. Galeana, Nuevo León, México.

THAMNOPHIS EQUES POSTREMUS Smith. Holotype.

Type. EHT-HMS, No. 5275. *Paratypes.* 5274, 5285-5286, Uruapan, Michoacán.
Publ. Zoologica, XXVII, pts. 3 and 4, Oct. 23, 1942, pp. 109-110.
Type loc. El Sabino, Michoacán. *Coll.,* H. M. Smith.

THAMNOPHIS MELANOGASTER CANESCENS Smith. Holotype.

Type. EHT-HMS, No. 5023. *Paratypes.* EHT-HMS, Nos. 4896, 4921, 4923-32, 4928A, 4934, 4936, 4939-41, 4942A, 4943, 4967-73, 4970A, 5020-22, 5024-13, all topotypes. No. 5019, Magdalena, Jalisco; Nos. 5064-65, Lake Cuitzeo, Michoacán; Nos. 5066-71, 8 mi. E. Celaya, Guanajuato.

Publ. Zoologica XXVII, pts. 3-4, No. 17, Oct. 23, 1942, pp. 117-120.

Type loc. Lake Chapala, Chapala, Jalisco, México. *Coll.,* H. M. Smith, July 2, 1935.

THAMNOPHIS VICINUS Smith. Holotype.

Type. EHT-HMS, No. 21539. *Paratypes.* 15897, topotype; 15893-15896; 15992-15995, Morelia, Michoacán.

Pub. Zoologica, XXVII, pts. 3 and 4, Oct. 23, 1942, pp. 104-106.

Type loc. Near Temaxcal, Michoacán, 20 km. E. Morelia. *Coll.,* E. H. Taylor, Aug., 1939.

TRIMERESURUS GARCIAE Smith [= *Trimeresurus melanurus* Müller.] Holotype.

Type. EHT-HMS, No. 24353. Orig. Dyfrig M. Forbes Coll. No. 882. *Paratype.* EHT-HMS, No. 21489, topotype.

Publ. Proc. Biol. Soc. Washington, 53, April 19, 1940, pp. 62-63, fig. 2.

Type loc. Near Cacoloapam, Puebla, México. *Coll.,* Dyfrig McH. Forbes, 1939.

XENODON MEXICANUS Smith. Paratype.

Paratype. EHT-HMS, No. 5207, Potrero Viejo, Veracruz, México.

Publ. Proc. Biol. Soc. Washington, 53, April 19, 1940, pp. 57-59.

Type loc. Piedras Negras, Guatemala.

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The Genera of Plethodont Salamanders in Mexico, Pt. I.

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ABSTRACT: The old genus *Oedipus* Tschudi (preoccupied by *Oedipus* Berthold, for a genus of Orthoptera, is considered as being composed of eight genera: *Chiropterotriton* gen. nov., *Pseudoeurycea* gen. nov., *Bolitoglossa* Duméril and Bibron, *Parvimolge* gen nov., *Thorius* Cope, *Oedipina* Keferstein, *Magnadigita* gen. nov., and *Haptoglossa* Cope.

INTRODUCTION

DURING the past twelve years, at occasional intervals, I have taken the opportunity to inquire into some of the more evident problems concerning Mexican lungless salamanders. In this length of time a rather surprising number of errors and additions to previous studies have come to light. Some have been recorded already; these and others are here summarized.

Until recently I followed Dr. Emmett Dunn in his use of the generic name *Oedipus* Tschudi for the group. Then, after Dr. Radclyffe Roberts pointed out to me that *Oedipus* Tschudi (1838) was preoccupied by *Oedipus* Berthold (1827) for an orthopteran genus, I recorded the suppression of Tschudi's name in the University of Kansas Science Bulletin, Vol. 26, No. 12, 1939 (1940), first submitting the case to the late Dr. Leonhard Stejneger, formerly a member of the International Commission on Zoölogical Nomenclature, who agreed that *Oedipus* Tschudi is not available.

In the same paper I revived Cope's genus *Thorius* for certain small Mexican salamanders, formerly associated with *Oedipus*, and used *Bolitoglossa* Duméril and Bibron for the remaining species in lieu of *Oedipus*.

A superficial examination of the numerous species of plethodontid

salamanders occurring in México, Central America and South America, showed the urgent necessity of a critical examination of these salamanders with a view of ascertaining whether Dunn was correct in lumping the thirty-one species treated in his "The Salamanders of the Family Plethodontidae" into a single genus, or whether they represented several genera and should be allocated accordingly. Early in my studies the existence of certain superspecific groups, not exactly those of Dunn, was recognized, and with the discovery of many new species by Mr. Karl P. Schmidt, Dr. L. C. Stuart, Dr. Hobart M. Smith, and myself, these groups took on more importance.

Unwilling to accept them as genera without more convincing evidence, in spite of their apparent distinctness, I embarked upon an investigation of their internal characters. In them, I found many strikingly distinctive features, correlated so completely with the groups already outlined that the existence of several genera in the *Oedipus* of Dunn (and others) became, in my opinion, an established fact.

The specimens of "*Oedipus*" which Dunn had available numbered 718, and 31 species were recognized. Compared to this number, I have examined more than eight times as many (something more than 6,000 specimens), chiefly in the collections made by Dr. Hobart M. Smith and myself, together with a considerable number of specimens in the Field Museum, Museum of Zoölogy of the University of Michigan, Museum of Comparative Zoölogy at Harvard College, American Museum of Natural History, and the United States National Museum.*

In this paper I am considering seventy-eight species † and subspecies, all known to the present, from the Americas south of the United States. This is two and one-half times the number of species recognized by Doctor Dunn. Certain of those that he did not recognize, were actually available to him, but were confused with other species. On the other hand, many have been discovered since the publication of his work. For some of the genera into which these species are here segregated, new generic names are required and are proposed herein.

It may be assumed that had all the species and material I have examined been available to him, Doctor Dunn would have arrived at much different conclusions from those expressed in his monograph.

* I desire to express my hearty thanks to the officials of these institutions who have made loans and exchanges of plethodontid salamanders and to Dr. Hobart M. Smith, who permitted me to study the material contained in the Mexican collection made by him and who has offered able advice in the preparation of this paper.

† I have seen two other species still undescribed.

The list of species recognized in this paper follows.

adspersa Peters
ahli Unterstein
alfaroi Dunn
altamazonica Cope
altamontana Taylor
arborea Taylor
barbouri Schmidt
bellii Gray
borburata Trapido
bromeliacea Schmidt
cephalica cephalica Cope
cephalica manni Taylor
cephalica rubrimembris Taylor and Smith
chiroptera Cope
chondrostega Taylor
cochranae Taylor
collaris Stejneger
colonnea Dunn
complex Dunn
cuchumatana Stuart
dimidiata Taylor
doffleini Werner
dubita Taylor
dunni Schmidt
elongata Schmidt
englehardti Schmidt
flavimembris Schmidt
flaviventris Schmidt
franklini Schmidt
gadovii Dunn
galeanae Taylor
gigantea Taylor
goebeli Schmidt
helmrichi Schmidt
lavae Taylor
leprosa Cope
lignicolor Peters
lincolni Stuart
lineola Cope
macrinii Lafrentz
melanomolge Taylor
mexicana Duméril and Bibron
mosaueri Woodall
morio Cope
mulleri Brocchi
multidentata Taylor
narisovalis Taylor
nasalis Dunn
nigroflavescens Taylor
nigromaculata Taylor
occidentalis Taylor
odonnelli Stuart
paraensis Unterstein
parvipes Peters
pennatula Cope
peruviana Boulenger
picadoi Stejneger
platydactyla Cuvier
pressicauda Cope
pulmonaris Taylor
rex Dunn
robertsi Taylor
robusta Cope
rostrata Brocchi
rufescens Cope
salvinii Gray
schmidti Dunn
smithi Taylor
striatula Noble
subpalmata Boulenger
sulcata Brocchi
terrestris Taylor
townsendi Dunn
troglodytes Taylor
uniformis Keferstein
unguidentis Taylor
yucatana Peters
xolocalcae Taylor

The following names have been proposed for species which have been referred to other known forms. Having seen but one of these types, I have no personal opinion as to the wisdom of certain of these synonymies. It is quite probable that some of these are good species. However, the types, if extant, will of necessity have to be carefully examined before the matter can be finally settled.

andicola = *adspersa* Peters (*fide* Dunn)
attitlanensis Brocchi = *salvinii* Gray (*fide* Schmidt)
bocourti Boulenger = *robusta* Cope (*fide* Dunn)
bocourti Brocchi = *rostrata* Brocchi (*fide* Dunn)
carbonaria Cope = *platydactyla* Cuvier (*fide* Dunn)
copei Brocchi = *platydactyla* Cuvier (*fide* Dunn)
estheri (*Eladinea*) Ribero = *altamazonica* (*fide* Parker)

gibbicaudus Blatchley = *leprosa* Cope (Based on same type)
infuscata Peters = *lineola* Cope (*fide* Dunn)
laticeps Brocchi = *cephalica* Cope (*fide* Dunn)
minima Wiedersheim = *pennatulus* Cope (*fide* Dunn)
orcula Cope = *chiroptera* Cope (*fide* Cope)
orizabensis Blatchley = *leprosa* Cope
palmata Werner = *altamazonica* Cope (*fide* Dunn)
simus Valliant = *altamazonica* Cope (*fide* Dunn)
togata Valenciennes (*nomen nudum*)
yucatanica Boulenger = *yucatana* Peters
punctatum = *platydactyla* Cuvier (*fide* Dunn)

REVIEW OF CLASSIFICATION SYSTEMS

In the past seventy-five years the classification of the lungless salamanders having a nasolabial groove has undergone few changes other than the addition of newly discovered species and genera. Edward Drinker Cope in 1869 presented a complete classification of the group in a paper‡ entitled, "A Review of the Species of the Plethodontidae and Desmognathidae." While this system was based on previous systems to some extent, Cope himself had investigated the anatomy of a great many of the forms concerned. His arrangement follows:

Family PLETHODONTIDAE

Genus *Plethodon*
Genus *Hemidactylium*
Genus *Batrachoseps*
Genus *Stereochilus*
Genus *Anaides*
Genus *Geotriton*
Genus *Gyrinophilus*
Genus *Manculus*
Genus *Opheobatrachus*
Genus *Oedipus*
Genus *Spelerpes*

Family DESMOGNATHIDAE

Genus *Desmognathus*

Family THORIIDAE

Genus *Thorius*

G. A. Boulenger, in his Catalogue of the Batrachia Gradientia s Caudata and Batrachia Apoda in the collection of the British Museum, 2d Ed., 1822, pp. 51-79, treats of the same group of salamanders under two subfamilies of the Family SALAMANDRIDAE as follows:

Family SALAMANDRIDAE

[Subfamily A SALAMANDRINAE]

[Subfamily B AMBLYSTOMATINAE]

‡ Proc. Acad. Nat. Sci. Philadelphia, 1869, pp. 93-118.

Subfamily C PLETHODONTINAE

Genus *Anaides*
Genus *Plethodon*
Genus *Batrachoseps*
Genus *Spelerpes*
Genus *Manculus*

Subfamily D DESMOGNATHINAE

Genus *Desmognathus*
Genus *Thorius*

This system lowered two of Cope's families to subfamily rank, and the third family *Thoriidae* was ignored, the genus *Thorius* being placed under the DESMOGNATHINAE.

Again in 1889 in his great monograph on The Batrachia of North America, Cope published a classification, using practically the same arrangement as was used in 1869, which recognized the DESMOGNATHIDAE, PLETHODONTIDAE and THORIIDAE as full families. The generic conceptions remained practically the same.

During the four subsequent decades both writers had their followers. As late as 1925 the Zoölogical Record was using Boulenger's subfamilies; and the Check List of North American Amphibians and Reptiles of 1922 was using Cope's arrangements and families and genera, as far as they applied to the American Fauna.

Cope (1893) apparently modified his idea of the importance of Family THORIIDAE, from that published earlier, and on the occasion of describing *Haptoglossa** referred the genus to the Subfamily THORIINAE in which he also places *Thorius* and *Oedipina*. One is in doubt as to whether it was regarded as a subfamily of the PLETHODONTIDAE or the DESMOGNATHIDAE.

In 1900 Cope's family DESMOGNATHIDAE (Boulenger's Desmognathinae) met some criticism from Percy Moore,† who endeavored to show that the group DESMOGNATHIDAE was not separable from the PLETHODONTIDAE on the basis of the character of the vertebral articulations which he erroneously believed was the only character of significance separating the two families.

In 1917 a new family, TYPHLOMOLGIDAE, was proposed by Stejneger and Barbour‡ for the genus *Typhlomolge*. Although this genus was subsequently referred to the Family PLETHODONTIDAE, these authors originally placed the family in a different suborder, the *Proteida*.

* Cope, Proc. Amer. Phil. Soc., 31, 1893, p. 334.
† Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 613-622.
‡ A Check List of North American Amphibia and Reptilia, Harvard Press, 1917.

Dunn's work on "The Salamanders of the Family Plethodontidae" is the most recent monographic treatment. In it he followed Moore by placing Cope's family DESMOGNATHIDAE in the family PLETHODONTIDAE. However, he does point out in this work many significant differences which obtain between the two groups. He states "Moore in 1900 showed that the difference between amphicoelous and opisthocoelous vertebrae was a matter of individual age, and that systematic divisions based on this character were worthless."

Further, Dunn places the THORIIDAE (THORIINAE) and the TYPHLOMOLGIDAE in the synonymy of the PLETHODONTIDAE.

The classification of the Plethodontidae used is as follows:

Family PLETHODONTIDAE

Genus Typhlomolge	Genus Ensatina
Genus Typhlotriton	Genus Plethodon
Genus Hemidactylium	Genus Gyrinophilus
Genus Batrachoseps	Genus Pseudotriton
Genus Stereochilus	Genus Eurycea
Genus Desmognathus	Genus Hydromantes
Genus Leurognathus	Genus Oedipus
Genus Aneides	

Among the generic changes proposed by Dunn, those treating of the salamanders south of the borders of the United States seem to be most open to question. Thus the genera *Oedipina*, *Oedipus*, *Haptoglossa*, and *Thorius* and certain forms referred by Cope and others to *Spelerpes*, are lumped together in the genus *Oedipus* Tschudi (preoccupied).

GENERAL CONSIDERATIONS

The salamanders of the family Plethodontidae, as interpreted by various recent authors, comprise a group extending from Alaska and Canada to Argentina and Bolivia, with a small remnant group occupying territory in Sardinia, southeastern France, and northwestern Italy. In the northern part of the range in the western hemisphere, the family has been broken up into a number of genera, about 17 being generally recognized at the present time, with some 79 species and subspecies. (Bishop, Handbook of Salamanders, 1943.)

Contrasting with this treatment in the north, most of the species occurring in México (exclusive of Baja California), Central and South America, have been thrown (following Dunn), into a single genus, which for the most part, has been recognized under the name *Oedipus* Tschudi (preoccupied by *Oedipus* Berthold for a genus of Orthoptera). The number of forms in this territory now known

number 80, and save for two, *Ensatina platensis* from Argentina and a *Batrachoseps attenuatus* in Colima, México, have been generally regarded as congeneric.

Dunn states that the large genus *Oedipus* (as he defines it) contains many extremes, and its range of variation exceeds that of most other genera so that definition of the genus is difficult—a statement which in itself strongly suggests that it is a composite. He further states that in the advent of the extinction of a few species, several genera (at least four) would be established.

Contrary to Dunn's statements, studies of the salamanders of his genus "*Oedipus*" demonstrate that he has included several generic groups, which, if all important characters are considered, form groups of equal importance and rank with the genera which he recognizes as occurring in the United States. These generic groups are not linked by annectant forms and are not "incipient" genera. If one were to unite all the plethodontid genera having a single premaxilla into a single genus or all of those having a free tongue into a genus, one would have groups no more heterogeneous than his "*Oedipus*."

Apparently Dunn made some effort to break up his genus "*Oedipus*." He arranges the species into four groups, of which he states: "They fall into the following groups, which would, if distinct enough and in the absence of annectant forms, rank as genera."

Group I. The primitive group, including*

bellii	*cephalicus*	*subpalmatus*	*chiropterus*
schmidti	*rostratus*	*adspersus*	*rex*
robustus	*morio*	*sulcatus*	

Group II. Small mountain forms with large nostrils.

townsendi	*nasalis*
pennatulus	*picadoi*

Group III. Species with fully webbed toes, almost all low country forms.

altamazonicus	*platydactylus*	*salvinii*
attitlanensis	*lignicolor*	*yucatanus*
striatulus	*colonneus*	*rufescens*

Group IV. Wormlike forms, low country species with elongate bodies and weak limbs, usually lacking sexual dimorphism and the basal constriction of the tail.

lineolus	*complex*	*uniformis*
collaris	*parvipes*	*alfaroi*

* *gadovii* is not placed in a group, but had it been considered would probably be here.

If we examine Group I, we will observe that it is composed of an association of at least three widely different generic groups. Each of these has a different type of foot, and one group differs also in having the sublingual fold absent. *Adspersus* may even represent a fourth generic group, since it is said to lack a prefrontal and is reported to be ovoviviparous.†

In his Group II are again associated forms belonging to at least three widely differing generic groups. These, however, have in common an enlarged nostril. *Nasalis* is a member of the same generic group as *chiroptera* of Group I; *pennatulus* is a *Thorius* and his *townsendi* has no close relatives. I do not know *picadoi* by autopsy and I am uncertain of its generic reference.

In Group III we find species which have greater warrant for the association and probably are all referable to the same genus.

His Group IV includes six elongate forms, and while all are apparently quite distinct from other generic groups, may consist of more than a single genus. However, Dunn states, in speaking of *collaris*, "Has no near relatives. Remotely allied to *parvipes*, *collaris* is like it a link between the mass of the genus and the forms which have been considered *Oedipina*. The distinction is broken down and I can no longer regard the latter genus as tenable." I am not clear what breaks down the distinction.

Concerning *parvipes* he says, "This animal breaks down the distinction between *Oedipus* and *Oedipina*. It is related to the more degenerate *alfaroi* of Costa Rica. The small eye, the long snout, the brown color, are the same in both. But *alfaroi* has 20 costal grooves as against 17 in *parvipes*, and there are no teeth on the maxilla."

If we examine some of the other presumed "links" which are supposed to connect the various groups we will find that some other interpretation is possible. For an example, it is presumed that *Thorius* was regarded as being linked to "*Oedipus*" by the discovery of *Oedipus townsendi*. That this does not obtain is shown by an examination of the forms that constitute the genus *Thorius*, in which we find the following characters held in common: Skull very poorly ossified; maxillary toothless; prevomers in contact anteriorly; frontal processes of premaxilla pass along the prevomerine suture; parietals widely separated by membrane; orbitosphenoids widely separated from parietals and frontals; premaxillary fontanelle re-

† Dunn apparently has the erroneous impression that the species of *Oedipus* are ovoviviparous. *Adspersus* is the only one that to my knowledge has been so described. See Dunn 1926 "Plethodontidae," pp. 47, 48.

duced, a deep orbitolabial groove. *Oedipus townsendi* agrees in none of these characters. It has a series of enlarged dorsal glandules, the maxillary has a large series of pleurodont teeth; frontal processes of the premaxillary do not pass along the common prevomerine suture; skull bony; the parietals forming a common suture; orbitosphenoid in contact with parietal and frontal; a well-developed premaxillary fontanelle; no orbitolabial groove. It differs also in numerous other characters. The species does, however, agree with *Thorius* in that both are small, and have a free tongue and large nostrils. In consequence of these differences it is absurd to regard *"Oedipus" townsendi* the connecting link between the genus *Thorius* and *"Oedipus,"* or *Thorius* and any other known generic group; or that it would be necessary for it to become extinct in order to recognize *Thorius* as a genus. The differences between *Thorius* and *Oedipina* are likewise equally as significant as those which obtain between *Thorius* and *"Oedipus" townsendi.*

Since Dunn does not state the articular variations which are to be found in the genera which he recognized in the plethodontids, one may presume that the data and material available to him were inadequate for him to make use of this character in delineating the genera; nor was he aware, apparently, of other vertebral characters which seem to be invariably present in given genera, and which might serve as additional discriminating characters between genera. Moreover, the presence or absence of a sublingual fold has either been overlooked or has been given no weight; adequate weight has not been given to the foot and hand characters, the differential characteristics of the premaxilla, the relationship of other skull bones, and the presence or absence of the prefrontal bones. The size of the nostril has perhaps been given more importance than it merits, since seemingly the large nostril may develop independently in unrelated genera or within a single genus, and of itself may not show other than ecological relationship.

In the specific treatment, Dunn has confused several species, misidentified some, and incorrectly synonymized others, and not impossibly, his erroneous grouping may be in part due to these errors. I have not as yet examined all the material seen by him. There are possibly other errors of identification than those listed here.

1. *Oedipus belli.*‡ Confuses *belli, gigantea* and *gadovii.* The

‡ The reference, p. 358, *Geotriton bellii* Garman states "p. 471." This is incorrect. The page is 39, and the combination as such is not used. The name *S. bellii* appears in a list under a genus, *Geotriton.*

latter is separated in the addenda as a distinct species. The synonymy of *bellii* still includes such references as apply to *gadovii*.

2. *Oedipus sulcatus*. This is not *Spelerpes sulcatum* Brocchi. The figure given by Brocchi shows a diminutive form having the fingers and toes more or less grown together (syndactylous). The specimens Dunn refers to this species are *smithi* (Taylor). I have elsewhere called attention to his error in the description (p. 260) which states "13 costal folds between adpressed toes." His statement, p. 33, "*sulcatus* from western Mexico," is incorrect. The actual type locality is unknown. Specimens which Dunn believed to be this form were from eastern Oaxaca.

3. *Oedipus chiropterus*. Dunn has referred the following numbers to *chiropterus* erroneously: M. C. Z., 3404 = *leprosus;* 8408 = *cephalicus*.

4. *Oedipus townsendi*. Dunn has confused two forms, *townsendi* and *dimidiata*. The specimens listed as cotypes from Hidalgo are of the latter species.

5. *Oedipus pennatulus*. Confuses four species: *Thorius narisovalis*, U. S. N. M., 47608; *T. pulmonaris*, U. S. N. M., 47797; *Thorius pennatulus;* and U. S. N. M., 30348, consisting only of a head, which is not of this species or genus, but a sharp-snouted species, perhaps an *Oedipina*.

6. *Oedipus cephalicus*. Confuses specimens of *Spelerpes leprosus* Cope, *Spelerpes cephalicus* Cope, *Oedipus* sp., *Spelerpes chiroptera*, and *Bolitoglossa nigropunctata* Taylor, with this species.

U. S. N. M., No. 123592, sp. unidentified, is certainly not *cephalica*. U. S. N. M., No. 6340 = *Bolitoglossa nigropunctata*, two specimens. M. C. Z., Nos. 8417, 8418, 8420, 8421, 8423, 8426, 8427, 8431, are *leprosa* (only a part of this series, M. C. Z., 8417-8432, seen). I originally assigned these to *Oedipus orizabensis*. An examination of a large collection from Orizaba shows only a single form, there being some difference in specimens from low and high elevations. I am considering these all as *leprosus*. Nos. 8419, 8424, 8428, 8429, and 8430 are *Pseudoeurycea cephalica*. No. 8432 is *Chiropterotriton chiroptera*.

7. *Oedipus salvini*. Confuses *Oedipus flaviventris* with this form (*fide* Schmidt, 1936).

8. *Oedipus attitlanensis* is a synonym of *Oedipus salvinii* (*fide* Schmidt, 1936).

9. *Oedipus altamazonicus*. Confuses *Spelerpes peruvianus* Boulenger with this form. *Peruvianus* is a distinct form (*fide* Parker, 1939).

10. *Oedipus adspersus.* A. M. N. H., Nos. 13058-9 and A. M. N. H., Nos. 10330-9, referred to *adspersus,* are not of that species.

11. *Oedipus morio.* According to Schmidt, specimens referred by Dunn to this form belong to a different species, *Oedipus dunni* Schmidt.

12. *Oedipus lignicolor.* Refers A. M. N. H., 21370 (yg., 33 mm. in length) to this form. It is an *Oedipina complex* with 17 costal folds.

13. *Oedipus yucatanus.* Confuses *Spelerpes doffleini* with this form; *doffleini* is distinct from *yucatanus.* (*Fide* Stuart, 1943).

14. *Oedipus platydactylus.* Confuses *Spelerpes mulleri* and *Bolitoglossa mexicana* with this species. These two forms, *mulleri* and *mexicanus,* are distinct. (*Fide* Schmidt, 1936 and Stuart, 1943).

15. *Oedipus rostratus* Dunn = *Oedipus morio* Cope. (*Fide* Dunn in Schmidt, 1933).

DISCUSSION OF GENERIC CHARACTERS

Foot and hand. Type I. The typical, primitive, unmodified, terrestrial forms have the digits unwebbed beyond the metatarsals or metacarpals, while certain more specialized ones may have the first phalanges partly or wholly included in the web. The phalanges are more or less hourglass-shaped, elongate, and the terminal ones are more or less widened at the tip. The phalangeal formula is normal and the digits are freely movable individually, while the terminal adhesive pads and the palm and sole are not strongly specialized. This group comprises a number of high mountain forms, and a few that tend to descend the sides of the plateau to lower elevations (in one case, that of *nigropunctata,* to less than four thousand feet). These species occupy territory from Nuevo León, to the central and southern parts of the Mexican plateau, and extend into Central America. Probably the oldest generic group of the family, the various species or species groups display greater differentiation one from another than those in other similar generic groups. Representatives of these generalized forms are *leprosus, altamontana, bellii, smithi, gadovii, goebeli, cochranae, galeanae, unguidentis, melanomolge, robertsi,* etc.

Type II. In the foot structure of this type, the digits of hand and foot are widespread, the subdigital termination bearing small, discrete, terminal pads which are truncate or, rarely, slightly pointed. The palm and sole are in the nature of a thick smooth pad which includes the proximal phalanges and the entire first toe and finger.

The digits are not, or but moderately, widened. In the young the nostrils are very large, a character which may or may not be retained in the adults. Some of the forms are terrestrial (*dimidiata, chiroptera, terrestris, chondrostega, mosaueri*), some arboreal or bromelicolus (*arborea, nasalis, lavae, xolocalcae*) and at least one both terrestrial and arboreal (*multidentata*), and they are chiefly high

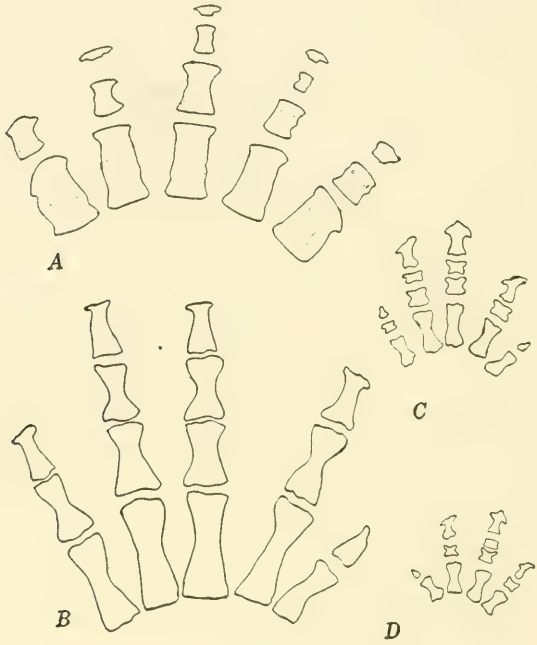


FIG. 1

A. *Bolitoglossa flaviventris* (Schmidt).
Metatarsals and phalanges of foot. (Foot type III.)
B. *Pseudoeurycea leprosa* (Cope).
Metatarsals and phalanges of foot. (Foot type I.)
C. *Thorius narisovalis* Taylor.
Metatarsals and phalanges of foot. (Foot type V.)
D. *Thorius narisovalis* Taylor.
Metacarpals and phalanges of hand. (? Foot type V.)

mountain dwellers. Species having hands and feet of Type II have a distribution from Nuevo León, México, south to Central America over the eastern part of the plateau.

Type III. A third type of foot and hand is present in a group of species which are chiefly Central American in distribution but with one or two representatives in the southern part of México. In this type the toes themselves are much widened and often sharply trun-

cate, the two middle digits being relatively shortened. The subterminal digital pads and the thick pad on sole and palm are reminiscent of those described in the preceding group. However, I do not regard the two types as representing close relationship since the groups (general) differ from each other in other fundamental characters, such as the absence of the sublingual fold, and the presence of typical amphicoelous veretebrae in that having the Type III foot. It may be presumed that any similarity between them is due to environmental circumstances which have brought about parallel de-

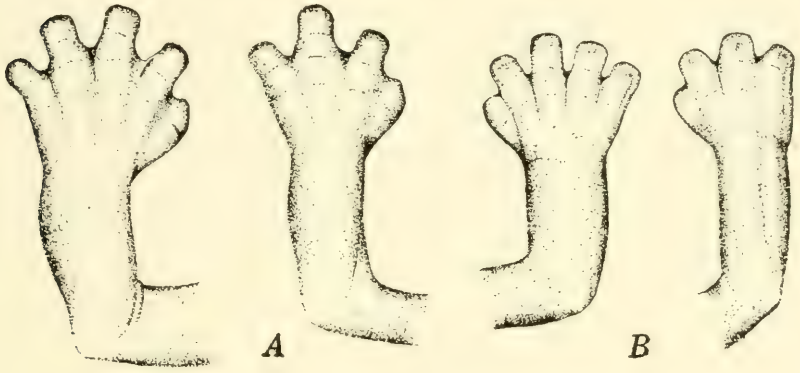


FIG. 2

A. *Magnadigita dunni* (Schmidt).
Foot and hand (enlarged). Field Mus. No. 4550, type. These represent typical hand and foot forms of Magnadigita.
B. ? *Magnadigita adspersa* (Peters).
Foot and hand. Amer. Mus. Nat. Hist. No. 13061.

velopment. However, Types II and III are readily distinguishable, the one from the other, and likewise, from other types here considered. Examples of Type III are *machrinii, nigroflavescens, flavimembris, robusta, dunni,* etc.

Type IV. A fourth group has the foot and hand completely or almost completely palmate, leaving only the extreme tips of the digits extending beyond the thick "web." In this group the digits may or may not be capable of independent movement. In undisturbed specimens the "web" is thick and is a continuous part of the pad that covers the sole and palm and includes the digits. In captured specimens when there has been much secretion from these pads, the "web," as such, is more evident. In some of the species, the individual digits are scarcely discernible exteriorly. On dissection certain of the phalanges are found to be shortened and

widened, the widening the result of the growth of a bony web along each side of the hourglass-shaped bone. The bony phalangeal formula may appear reduced since the terminal phalanges may be represented by only a minute cartilage. Members of this group are normally bromelicolus and their presence on the ground is for the most part accidental or temporary. It may be presumed that this type of foot is most efficient in moving over the smooth-leaved bromelias and plaintains; and likewise it has permitted the development of the larger arboreal forms. Examples of this group are *platydactyla, mexicana, flaviventris, lignicolor, yucatana, salvinii, rufescens*, etc.

Type V. It is not so easy to explain a fifth modification which involved the fusion of the digits for a part or the whole of their length, the digits themselves not being involved in a palmate pad, but retaining their individuality. Sometimes the types are rounded and partially free, sometimes sharply pointed at their terminations, and fused almost to their tips. With variations, this foot type is present in several small generic groups. The members are terrestrial or fossorial, living under leaves, rocks, or tending to burrow in rotting logs and detritus of various types. Generic examples are *Batrachoseps, Oedipina, Thorius*, etc.

Accepting the presumed aquatic origin of the plethodontids as fact, it would appear that webbing of the digits did not develop in response to the swimming stimulus, since the tail and not the limbs was the chief primitive organ of locomotion. The feet of salamanders with aquatic habitats usually are but little modified.

On land, however, a number of factors may be involved in changing the character of hand and foot. One might postulate that the winds which are responsible for the distinct wet and dry season are the remote stimulus for the development of the "webbed" foot in many of the salamanders. The winds prevent rain and tend to bring about a lack of surface moisture. This drives the salamanders to occupy, perhaps first, thick clumps of grass, terrestrial bromeliads and bromelia-like plants which can collect water, and then later, as they become still more modified by increase in the adhesive pads, to occupy the arboreal species of the families of water collecting plants.

The terminal phalanges of the unwebbed, relatively narrow-toed forms usually have a slight terminal widening, often described as "T-shaped." This widening may be absent on certain of the toes, the bone assuming the shape of a modified claw. This widening likewise is present in the partly webbed groups.

It would appear that the "webbing" is brought about by an increase in the number of small glands, which push along the digits and between the digits. This "web" provides a greater glandular surface for hand and foot so that the animal is enabled to ascend trees and climb about on smooth-leaved plants which hold moisture or collect it during the dry season. Usually the glandular web is not movable, and the digits of the hand and foot are kept continually widespread, apparently largely incapable of independent movement.

Sublingual fold. The sublingual fold appears in certain genera, and is absent in others. Its presence may have something to do with the ancestral condition, where the tongue is normally attached throughout life. Thus in certain very young specimens of a species, free-tongued in an adult state (removed from the egg), it appears that the tongue is attached. In *Haptoglossa* the tongue remains attached in the adult, as is likewise true of *Batrachoseps*, and the raised line of attachment is seemingly equivalent to the fold of the free-tongued forms. The character of the fold itself differs somewhat in the different genera of both free-tongued forms and those with attached tongues, in which it is present.

In at least a part of the genera having the tongue attached anteriorly (*Batrachoseps*) there is a distinct sublingual fold, and the attachment is along the median part of the fold for a greater or lesser distance. In *Eurycea*, in which the tongue is free, the fold is present in most if not all the species (all not examined). In *Pseudotriton* the membranes of the floor of the mouth are ample but the sublingual fold is scarcely represented in certain forms. The reduction of the membranes of the floor of the mouth and the complete absence of the fold seems especially significant in the genera *Bolitoglossa* (*sensu stricto*), and in *Magnadigita*, a genus herein described.

Intervertebral articulation. The vertebral articulation present in fully developed specimens of the salamanders under discussion fall into three general classes: amphicoelous, intermediate, and opisthocoelous. In the amphicoelous type, the intervertebral notochordal material, always present in the embryo, remains as embryonic protocartilage, or is replaced by true cartilage. Usually when the vertebrae are separated, the greater part of the cartilage adheres to the anterior part of a centrum. If the animal is macerated, or is allowed to rot, the cartilage disintegrates completely, leaving two cone-shaped cavities in the ends of the centrum.

In the intermediate class there is some calcium deposited in the

cartilage, and this adheres to the deeper part of the cup, or may fill up the entire cup to the posterior level of the centrum. This is a progressive process, the younger specimens showing less deposit than very old specimens.

In the true opisthocoelous type, the entire intervertebral cartilaginous mass becomes calcified (or ossified) and is attached to the anterior part of a centrum, filling the entire cup of the centrum and also forming the ball, of a ball and socket joint, for articulation with the preceding vertebra. In younger specimens the deposition may not fill the cup and in still younger specimens the material may be cartilage. Thus unless a knowledge of the size and age of a specimen in relation to the normal maximum of the species is known, conclusions based on vertebral articulations are apt to be misleading, as might be true of any animal with an adult bony skeleton, since the young might show much more cartilage. However, if one is able to examine old adult specimens, there is as great a specific and generic constancy in vertebral articulation as obtains in any character.

The use of the vertebral articulations as a basis for discrimination between the families Desmognathidae and Plethodontidae was criticised by Percy Moore* because he had noted that certain salamanders which in early stages may be amphicoelous are strictly opisthocoelous in old age. On the basis of the literature he regarded the character of vertebral articulation as the only significant difference between the families. He therefore decided that the family PLETHODONTIDAE and DESMOGNATHIDAE should be united because "the failure of the only important character which has seemed to make the family distinction of the PLETHODONTIDAE and DESMOGNATHIDAE desirable renders their separate continuance no longer necessary."

Dunn, apparently misled in a measure by the Moore paper, erroneously makes a wide application to any "systematic division." His statement is,† "Moore in 1900 showed that the difference between amphicoelous and opisthocoelous was a matter of individual age, and that systematic divisions based on this character were worthless."

If we agree that species and genera are "systematic divisions," the above statement is not wholly true since Moore's findings do show that certain genera (genera established on other characters) may or do have fixed, old-adult characters as regards vertebral articulation. Thus, he points out the following facts (Moore, p. 618).

* Proc. Acad. Nat. Sci. Philadelphia, 1900, pp. 613-622.

† The Salamanders of the Family Plethodontidae, p. 38.

Hemidactylium always strictly amphicoelous.

Plethodon (four species) amphicoelous.

Autodax (one species) biconcave.

Oedipus variegatus [= Bolitoglossa platydactla] biconcave, but "the anterior cup about one-third filled with calcified cartilage."

Gyrinophilus porphyriticus opisthocoelous, the anterior cup filled or with the calcification extending beyond the rim of centrum.

Spelerpes bellii [= *Pseudoeurycea bellii*] amphicoelous, but with a possibility that it may change later in life (as it does not agree with the development in the three forms of *Spelerpes*). [*bellii* actually belongs to a different genus.]

Spelerpes longicaudus [= *Eurycea longicauda*], *Spelerpes bilineatus* [= *Eurycea bislineata*] and *Spelerpes guttolineatus* [= *Eurycea longicauda gutto-lineata*] opisthocoelous (the anterior cups filled and with only a slight concavity).

Skeletal characters. Many if not all of the individual species segregated on the basis of the foot characters, presence or absence of the sublingual fold, and the characters of the vertebral articulations, may likewise show other skeletal characters in common which point to generic relationships. Thus in the group having the Type II foot, one may observe that the parasphenoid has a characteristic lateral notch; the orbitosphenoid is narrowed posteriorly, then suddenly widens to its greatest width anterior to the middle, then again becomes gradually narrower anteriorly; the brain case is wider in proportion to length than in certain other groups.

Certain of the generic groups have the dorsal ridge on the vertebrae well developed; in others it is low; while in still others scarcely a trace remains.

In certain of the genera there are no small lateral spines or "wings" on the side of the posterior part of the centrum, while they are present in two of the groups.

One genus *Oedipina* has a broad winglike bony development extending from the transverse processes along the posterior part of the vertebra.

I cannot distinguish any of the groups by the characters of the ribs or the transverse processes, yet some differences are present when individual ribs or individual vertebrae are compared. Contrary to Dunn's statement,‡ the ribs are, with few exceptions, forked

‡ Dunn states, "The ribs like those of Salamandridae and Ambystomidae, are forked distally" (p. 44, "The Salamanders of the Plethodontidae"). The ribs of the Salamandridae and Amblystomidae are likewise forked proximally.

proximally and not distally. Only the ribs of the second and third vertebrae may be also forked distally, that is, forked at both ends.

Dental characters. For the most part, the maxillary teeth of the southern plethodontids are pleurodont in character. However, in one genus, having the completely palmate hand and with the sublingual fold entirely missing, the teeth arise from the flat surface of the bone, rather than from along the edge of the maxilla. The teeth are relatively small and weak, reduced in number, and in two forms are apparently completely absent in adults.

With the exception of this group, there is constancy in the presence or absence of the maxillary teeth. In *Thorius* they are invariably absent in the known species, and invariably present in the other generic groups under consideration.

The maxillary teeth are normally in a single row in most of the genera save that in *Batrachoseps* there may be several rows present.

Prevomerine teeth are in one continuous row in most species; however, in younger specimens of certain species, in both young and adults of others, there may be several short rows which give the teeth a grouping often designated as a "patch." This condition appears in certain species of *Batrachoseps,* and is present in *Bolitoglossa yucatana* and occasional *Bolitoglossa platydactyla.* Some specimens of *Pseudoeurycea cephalica* likewise may have the prevomerine teeth in a patch.

The teeth, widely known as "parasphenoid teeth," appear on two bony plates which are loosely attached to the undersurface of the parasphenoid. These plates are generally regarded as backward growths of the prevomers and in some genera remain unseparated from them, as continuous processes of the prevomers. However, in most genera they form two separate bones which bear larger or smaller series of teeth. The name *paravomers* for these separate elements has been suggested to me by Dr. Hobart M. Smith, a suggestion which I shall follow.

These bones are variable in width, sometimes narrow, widely separated, and having several very short diagonal rows of teeth, sometimes much widened, so that the two plates are continuous, bearing several long diagonal rows of teeth, the rows from the two bones tending to meet mesially and together forming a pattern of chevrons. When the specimens are allowed to macerate, these plates separate readily from the parasphenoid, since they are not sutured to the parasphenoid or to each other. The teeth themselves rot away at their bases and are lost, since the tooth base is not solid dentine or dentine and enamel like the remainder of the tooth.

When the paravomerine teeth are described as forming a single "patch," one must know that they are merely the same two groups (normally forming two series) that have become closely approximated.

The width of the paravomers is apparently not a generic character in all cases, as several of the generic groups outlined previously may have these tooth groups separated in some of the larger members and closely approximated in certain of the more diminutive species. In certain other generic groups there is constancy in the character of their close approximation.

The sexual differention in the tooth characters is marked, at least in adults. Practically all the species have dental dimorphism which in the males results in larger teeth on maxilla and more especially the premaxilla. In a large number of cases the males have a smaller number of teeth on maxilla, premaxilla, and mandible. The dimorphism is either absent or less obvious as applies to the paravomerine and prevomerine teeth. As has been frequently pointed out, the premaxillary teeth of males often pierce the gums, and are visible even when the lips are closed. Moreover, the actual shape of the teeth, as well as the size, may differ in the two sexes. Some species may have the tooth tips darkened, some blackish, some reddish in color.

GENERIC GROUPS

Of the genera herein discussed, *Bolitoglossa, Pseudoeurycea, Chiropterotriton, Magnadigita, Parvimolge*, and *Oedipina* have the following characters in common: Digits, four anterior, five posterior; teeth invariably present on the paravomers, mandibles and premaxilla; premaxilla single; a fontanelle present between the frontal processes of the premaxilla and frontal; choanae open through a notch in the prevomers, no ossified pterygoids or pterygoid process on the squamosal or quadrate; otic capsule (periotic) never divided into two (or more) bones; occipital condyles sessile; operculum present; no bony septomaxilla. Tongue and hyoid apparatus attached to ventral surface of pelvis by two greatly elongate, narrow muscles; uniform hyoid apparatus; tongue boletoid, free; a nasolabial groove; carpals and tarsals of cartilage; lungs absent; frontal processes of maxilla never suturing or fusing behind fontanelle; atlas with two small spines on centrum, the anterior process ("odontoid process") with two articulating surfaces; eyes normal; no palmar tubercles; a specialized glandular area behind insertions of hind limb in both sexes; sexual dimorphism indicated by papillae in male cloaca, folds

in females; a submental (hedonic) gland in males; subnasal region more inflated in males; females usually larger, the body slightly longer in proportion to length of limbs.

The characters by which the genera vary are: the presence or absence of the prefrontal; character of maxillary teeth; presence or absence of a sublingual fold; character of feet, indicating adaption to terrestrial, subterrestrial, semiarboreal or bromeliad life; degree of ossification and relationship to each other of various bones of the skull; crests, wings or spines on dorsal vertebrae; the character of vertebral articulation (amphicoelous, opisthocoelous, or intermediate).

Too few of the characters of *Haptoglossa* have been given to compare it fully with the above group of genera. The fact that the tongue is not free sets it apart from *Thorius* and the above group of genera.

Thorius differs from the preceding group of genera in the foot characters; presence of an orbitolabial groove; separated parietals; absence of maxillary teeth; median part of brain case membrane; some forms with ossified carpals and tarsals; otic capsule and mandible rather well ossified while many other skull bones remain either cartilage or very weakly ossified; vertebrae opisthocoelous with rounded, anterior, articular condyles; fontanelle between frontal and frontal process of premaxillary, reduced.

Batrachoseps, also entering the Mexican fauna, has multiple tooth series on maxilla, digits 4-4, tongue not free; parietals, widely separated, the median part of brain case membrane; frontal processes of premaxillary fused, or not, the fontanelle reduced or absent; septomaxilla present (*fide* Dunn); no prefrontal; vertebrae preceding the sacral vertebra more than 15.

PSEUDOEURYCEA genus novum

Genotype *Spelerpes leprosus* Cope

Characters. Middle digits of hand and foot free beyond the metatarsals and metacarpals or at most involving the proximal phalanges; vertebral articulation intermediate, the cavity of the anterior part of centrum may be filled to the posterior surface of centrum, but lacking any trace of a rounded, terminal condyle; teeth on maxilla, premaxilla and mandible, pleurodont; premaxilla single, the frontal processes arising from a slight elevation on premaxilla; a well-defined fronto-premaxillary fontanelle; columella absent from the operculum; parasphenoid lacking a lateral notch; no septomaxilla; no lateral spines or "wings" on the posterior parts of centra (save atlas); a sublingual fold present.

Referred species. The species referred to this genus fall into several groups which are of almost generic character. Thêse are:

GADOVII GROUP

Pseudoeurycea gadovii (Dunn)
Pseudoeurycea unguidentis (Taylor)
Pseudoeurycea melanomolge (Taylor)

SMITHI GROUP

Pseudoeurycea smithi (Taylor)

CEPHALICA GROUP

Pseudoeurycea galeanae (Taylor)
Pseudoeurycea cephalica cephalica (Cope)
Pseudoeurycea cephalica manni (Taylor)
Pseudoeurycea cephalica rubrimembris (Taylor & Smith)

BELLI GROUP

Pseudoeurycea bellii (Gray)
Pseudoeurycea gigantea (Taylor)

LEPROSA GROUP

Pseudoeurycea altamontana (Taylor)
Pseudoeurycea cochranae (Taylor)
Pseudoeurycea robertsi (Taylor)
Pseudoeurycea leprosa (Cope)
Pseudoeurycea nigromaculata (Taylor)
Pseudoeurycea goebeli (Schmidt)
Pseudoeurycea rex (Dunn)
?Pseudoeurycea barbouri (Schmidt)

The range of this genus extends from Zacatecas and Nuevo León

PLATE XII

FIG. 1. *Pseudoeurycea gadovii* (Dunn). Hand and foot. EHT-HMS, No. 17176, topotype; Orizaba Volcano, 11,000 ft.

FIG. 2. *Pseudoeurycea robertsi* (Taylor). EHT-HMS, No. 12503, type; Nevada de Toluca, México.

FIG. 3. *Pseudoeurycea smithi* (Taylor). Hand and foot. EHT-HMS, No. 3966, type; Cerro San Luis N. W. Oaxaca, Oaxaca.

FIG. 4. *Pseudoeurycea altamontana* (Taylor). Hand and foot. EHT-HMS, No. 12245, type; Lake Zempoala, Morelos.

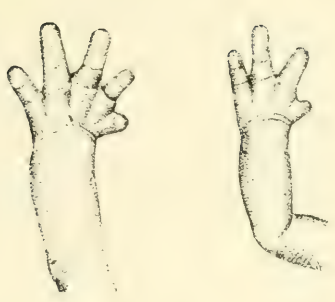
FIG. 5. *Pseudoeurycea cephalica cephalica* (Cope). Hand and foot. EHT-HMS, No. 12098, Lake Zempoala, Morelos.

FIG. 6. *Pseudoeurycea leprosa* (Cope). Hand and foot. EHT-HMS, No. 12215, near Río Frío, México.

FIG. 7. *Pseudoeurycea gigantea* (Taylor). Hand and foot. MCZ, No. 8437, type; Jalapa, Veracruz.

FIG. 8. *Pseudoeurycea goebeli* (Schmidt). Hand and foot. EHT-HMS, No. 29879, paratype; Volcan Tajumulco, Guatemala.

PLATE XII



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south on the Mexican Plateau, two forms, *rex* and *goebeli*, occurring in Guatemala. Only one species, *Pseudoeurycea bellii*, is known to occur in the Sierra Madre del Sur in Guerrero, where it is the only known salamander.

The genus *Pseudoeurycea* has undergone its greatest development in the plateau region of México, practically no part of which lacks a representative (with the possible exception of the most northwestern part). At least five subgeneric groups are present, and usually only one species of any given group occurs in a given locality. Thus in the general region on and about Mt. Orizaba one species belonging to each of four groups occur: *Pseudoeurycea gadovii, cephalica cephalica, gigantea* and *leprosa*. On Mt. Popocatepetl three groups, represented by four species, *bellii, cephalica cephalica, leprosa* and *altamontana* occur. On Cerro San Felipe, Oaxaca, *bellii, unguidentis, smithi* and *cochranae* are found—four species representing four groups. On Nevado de Toluca, in western México (state), *robertsi, bellii* and *cephalica cephalica* occur—three species and three groups.

Thus in only one case (Mt. Popocatepetl) do we find two species of one group represented—that *leprosa* and *altamontana*. The two forms also occur together in the Ajusco range (Lagunas de Zempoala).

On the periphery of the range, in the north only *cephalica galeanae* has been found; to the west in Jalisco, Zacatecas, and south in Guerrero only *bellii;* in lower elevations in the east (Veracruz) only *nigromaculata* is known to occur.

When the internal anatomy of the *leprosa* group is better known, the differences between *altamontana* and *leprosa* may be found to be greater than they now seem to be. In Guatemala it has not been shown that *rex* and *goebeli* occur together.

Oedipus barbouri Schmidt is referred to this genus with a question. The toes are free. Whether the sublingual fold is present has not been ascertained.

CHIROPTEROTRITON genus novum

Genotype *Oedipus multidentata* Taylor

Characters. Small mountain salamanders adapted to both terrestrial and arboreal life. Hand and foot widespread, the proximal phalanx of each digit included in the fleshy web; under surface of digit tips with discrete, rounding, elevated pads, thickest posteriorly; first finger and first toe almost completely included in web; the last finger and toe well developed; palm and sole a glandular pad which is smooth, not showing the metatarsals and metacarpals. Tongue free with a membranous semicircular sublingual fold below anterior part of tongue (or somewhat anterior to it). Young with much enlarged nostrils, retained in certain adult forms. Teeth typically pleurodont on maxillary, premaxillary and mandible; paravomerine tooth patches either separate or closely approximated and forming a single patch; mandible usually not strongly ossified; carpals and tarsals of cartilage; metatarsals, metacarpals and phalanges well ossified; phalanges hourglass-shaped; terminal phalanges with a narrow or a wider, T-shaped termination.

The following characters are also common to most if not all the species. The premaxilla is single and is usually well ossified, narrow, bearing from seven to nine teeth; the frontal processes arise separately and pass up and back, separated from the skin by a thin mass of glands; the processes are attached to the nasals and frontals, and border a fontanelle lying partly between the anterior ends of the frontals and the processes; maxillaries and mandibles always toothed. Prevomers separated anteriorly, sutured only posteriorly, usually at about the level of the posterior edge of the choanal opening, touching the edge of premaxilla narrowly, widely separated from frontal or premaxillary processes. Paravomerine teeth on parasphenoid in two groups, narrowed somewhat anteriorly, and close together, wider and more separated posteriorly. Orbitosphenoid widest medially, narrowing at both ends, bordered above by the frontal and parietal, ventrally by the parasphenoid; optic foramen large, usually its diameter equal to half the posterior width. Frontals and parietals forming median sutures. Otic capsules (periotic) well

PLATE XIII

FIG. 1. *Chiropterotriton bromeliacea* (Schmidt). Hand and foot. EHT-HMS, No. 27090, paratype; Volcan Tajumulco, Guatemala.

FIG. 2. *Chiropterotriton chiroptera* (Cope). Hand and foot. EHT-HMS, No. 4475; km. 67, México-Puebla Highway, México.

FIG. 3. *Chiropterotriton lavae* (Taylor). Hand and foot. EHT-HMS, No. 28937, type; 2 mi. W. La Joya, Veracruz.

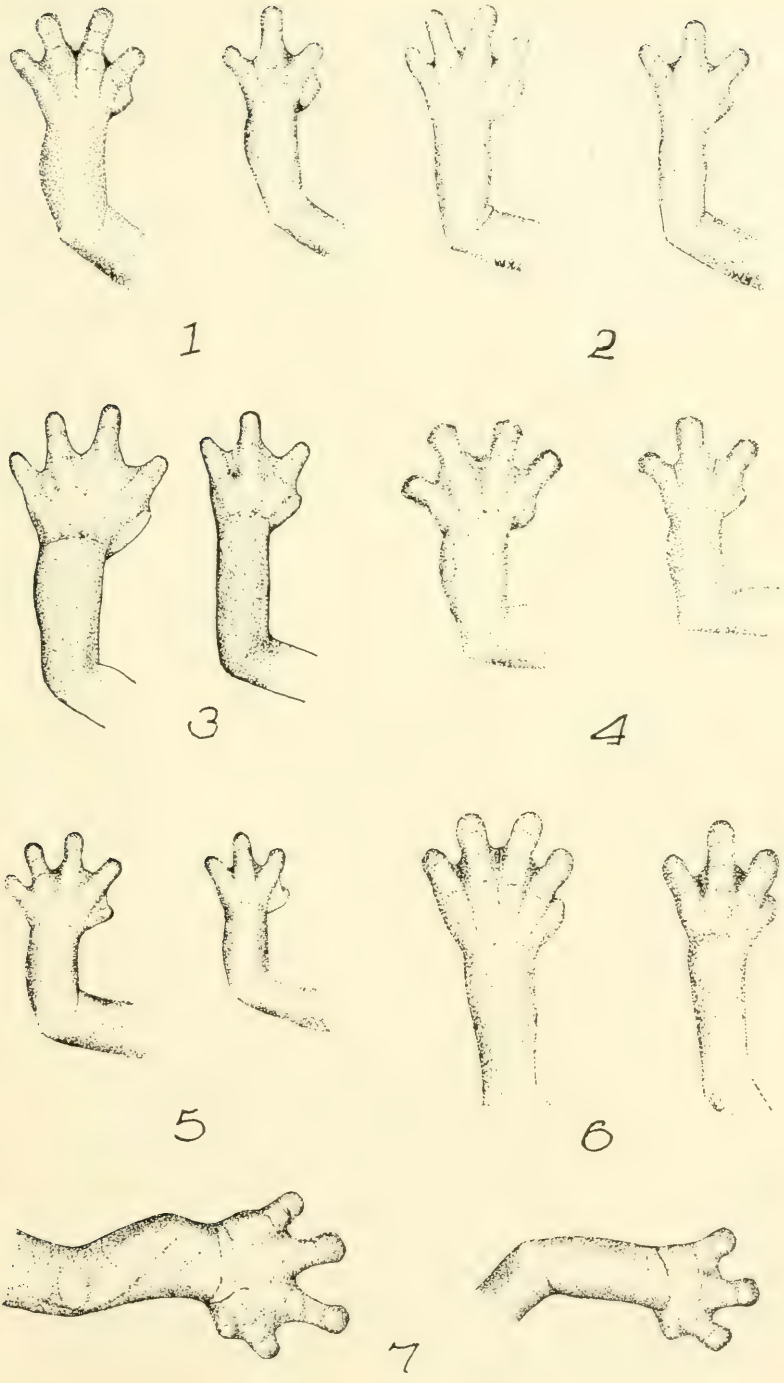
FIG. 4. *Chiropterotriton arborea* (Taylor). Hand and foot. EHT-HMS, No. 16734, type; near Tianguistengo, Hidalgo.

FIG. 5. *Chiropterotriton nasalis* (Dunn). Hand and foot. EHT-HMS, No. 27286, paratype; mountains above San Pedro, Honduras.

FIG. 6. *Chiropterotriton multidentata* (Taylor). Hand and foot. MCZ, No. 14812, paratype; Alvarez, San Luis Potosí (8,000 ft.).

FIG. 7. *Chiropterotriton xolocalcae* (Taylor). Hand and foot. EHT-HMS, No. 25331, paratype; Cerro Ovando, Chiapas.

PLATE XIII



ossified, lacking crests or spines but with three low, elongate, dorsal ridges, forming a triangular dorsal depression; lachrymal foramen between prefrontal, maxillary and nasal; operculum a flat plate, from the edge of which arises a short columella. Fifteen vertebrae precede the sacral vertebrae; no dorsal crests present and no spines on centra save on sides of atlas; atlas not modified.

Referred species. Besides the genotype, *Chiropterotriton multidentata* (Taylor), the following species are referred to the genus:

Chiropterotriton chiroptera (Cope)
Chiropterotriton dimidiata (Taylor)
Chiropterotriton chondrostega (Taylor)
Chiropterotriton mosaueri (Woodall)
Chiropterotriton arborea (Taylor)
Chiropterotriton terrestris (Taylor)
Chiropterotriton lavae (Taylor)
Chiropterotriton xolocalcae (Taylor)
Chiropterotriton nasalis (Dunn)
Chiropterotriton bromeliacea (Schmidt)

Remarks. The terrestrial types are *chiroptera, dimidiata, chondrostega, terrestris, mosaueri* and *multidentata.* The first mentioned form, *chiroptera*, is found most frequently under pine and other logs or in the crevices of rotting wood, under rocks, clumps of grass and piles of leaves. I have never taken the species in either terrestrial or arboreal bromelias. However, there are usually no, or but few bromelias in the regions, and at the elevations, where the species is most numerous. The species has been taken most frequently at from 9,000 to 12,000 feet elevation. In the region of the Lagunas de Zempoala, and elsewhere in the Ajusco range in eastern México and western Puebla (Mt. Tlaloc, Ixtaccihuatl and Popocatepetl) and east in the region of Cofre de Perote, Veracruz, this species is very numerous.

During the dry season this form finds shelter deep among rock piles, in the roots of rotting stumps and sometimes in the thick basal masses of the mountain grass clumps, which remain moist during much of the dry season. My first visits to the northern slopes of Cofre de Perote were made in June at which time the specimens were extremely numerous at Cruz Blanca. The place was visited later in the season on two or three occasions and not a single specimen could be found where literally thousands might have been collected earlier.

Chondrostega resembles *chiroptera* in most details but the skull is largely cartilaginous, the bones are extremely fragile (especially the vertebrae and limb bones), and the atlas is shortened. The foot shape is almost identical with that of *chiroptera*, and its habitat is likewise similar. The species has been found only in the general region about the type locality. None have been taken in bromelias —in fact no bromelias were observed in this immediate region.

Mosaueri occurs in this same locality but I suspect that this species is subterrestrial, living in the cavities in limestone rocks, which are

abundant in this region. The types were found in the mouth of a small cavern some feet below the ground.

Arborea and *terrestris*, two other members of the genus, occur in central northern Hidalgo and may actually be present in suitable localities in the same region where *chondrostega* and *mosaueri* occur. In the mountain region in southern Hidalgo two other forms, *multidentata* and *dimidiata*, occur, the latter known only from this range, the other, *multidentata*, occurring as far north as San Luis Potosí. I have seen an undescribed species of this genus that was taken on Cerro Potosí near Galeana, Nuevo León.

Chiropterotriton lavae is known only from bromelias on the plateau edge in central western Veracruz, but I suspect it is likewise to be found in the lava rocks which occur in such abundance in the region. To the south a species, *xolocalcae*, has been recently discovered on Mt. Ovando, southern Chiapas. It is so far known only from the bromelias of this region. Still farther southeast *nasalis* occurs. This latter form apparently is also largely or entirely bromelia-inhabiting. It combines the character of small fingers and toes (similar to *chiroptera*) with a very large nostril.

Multidentata, occurring in the mountains of Hidalgo and San Luis Potosí, is a form that is both terrestrial and arboreal, and is apparently the most generalized form. During the wet season the greater number of specimens were to be taken on the ground, while a few only were to be found in bromelias. The elevation at which the species occurred most frequently was 9,000 to 11,000 feet. It differs from *chiroptera* in the retention of all or most of the maxillary teeth in the males (all but a few enlarged teeth are lost in *chiroptera* males), longer tail, longer limbs and a slightly wider skull. Proportionally the digital tips are very slightly wider than in *chiroptera*.

Arborea, *chiroptera* and *lavae* have a small number of enlarged teeth on the maxillaries of the males. The sublingual fold under the tongue (or slightly in advance of it) is always present. It may represent a line of lingual attachment in its ancestors. It is not to be confused with the membrane attaching the ceratobranchial heads, immediately anterior to the base of the tongue.

The evolution of this generic group has taken place largely in México. *Multidentata* appears to be a more generalized form and I suspect this or a related form may be ancestral to the group. The other species all may be regarded as more specialized. This specialization is largely evidenced by reduction in size, variation in dental characteristics (chiefly the size, shape and number of teeth). While

there is a variation in length of limb with relation to body length and size of foot, the general *shape* of the foot, its pads and its widespread character remain unchanged. The slight increase in the length of limb and width of the toes in *arborea* is an adaptation to a more complete bromeliad habitat. The paravomerine tooth groups are close together in *dimidiata, terrestris* and *chondrostega,* which may be a result of the small size of these forms.

When the Central American countries south of Guatemala are better explored herpetologically, it seems likely that the genus will be traced farther to the south than it is now known.

MAGNADIGITA genus novum

Genotype *Bolitoglossa nigroflavescens* Taylor

Characters. Digits wide, more or less truncate, the outer one or two phalanges greatly shortened and free. No sublingual fold; metatarsals, metacarpals and phalanges poorly ossified; prefrontals present, premaxilla single, the spines arising separately; vertebrae completely amphicoelous, the centra large, thin walled, with a lateral keel or wing on the side; maxilla toothed; tongue free; no septomaxillae; occipital condyles sessile; carpals and tarsals cartilage; atlas with narrow winglike shelf along centrum instead of the two lateral spines, not obviously specialized; phalanges compressed, flattened, with some evidence of a lateral bony web. Usually (if not invariably) oviparous.

The foot pattern is held with rather rigid tenacity throughout the range, only that of *Magnadigita flavimembris* showing a slight departure from the typical (see Pl. XIV, fig. 8).

Referred species: Aside from the genotype *Magnadigita nigroflavescens* (Taylor), the following species are associated with this genus: *Magnadigita macrinii* (Lafrentz); *Magnadigita lincolni* (Stuart); *Magnadigita englehardti* (Schmidt); *Magnadigita rostrata* (Schmidt); *Magnadigita robusta* (Cope); *Magnadigita franklini* (Schmidt); *Magnadigita flavimembris* (Schmidt); *Magnadigita dunni* Schmidt; *Magnadigita cuchumatana* Stuart; ? *Magnadigita morio;* ? *Magnadigita adspersa* (Peters); ? *Magnadigita subpalmata* Boulenger. The three last species are referred here tentatively.

The Mexican species of this genus are confined to the southern part of the country, *Magnadigita macrinii* being known only from a range of mountains in southern Oaxaca, and *Magnadigita nigroflavescens* from Mt. Ovando in southwestern Chiapas. Other species range south through Central America and into South America.

BOLITOGLOSSA Duméril and Bibron

GENOTYPE *Bolitoglossa mexicana* Duméril and Bibron

Characters. Digits 4-5; feet and hands palmate, none or only tips of digits free; no sublingual fold; prefrontal present; premaxilla single, the spines arising separately; a fronto-premaxillary fontanelle; teeth on maxilla (normally) but these not typically pleurodont, but arising from flat surface of bone, and not at the edge (two forms lack teeth). Tongue free, but no trace of a sublingual fold; vertebrae completely amphicoelous; no bony septomaxillae; occipital condyles sessile; carpals and tarsals cartilage; metatarsals, metacarpals, and phalanges compressed, hourglass-shaped with lateral bony webs; phalangeal bony formula may be reduced (some of the terminal phalanges represented by cartilage only); oviparous; no aquatic stage; costal grooves 13, costal folds 12; 15 vertebrae precede the sacral vertebra; spines on sides of posterior part of centra; atlas not obviously specialized; paravomerine tooth patches on the parasphenoid closely approximated.

The species of the genus have greatly enlarged nasal capsules which extend in both sexes out over the upper lip. The premaxilla is single, reduced, weakly ossified, the base lying almost horizontal, the frontal processes pushing up between the nasal capsules near their posterior part; the nasal bones are relatively very large, generally triangular in shape, and may touch each other above the premaxillae. At least certain forms (*flaviventris*) have only eight carpals. The prefrontals are greatly reduced, but usually if not always form a part of the border of the lachrymal foramen; the choanae open through a notch in the prevomer.

Referred Species. Species are referred to the genus, as follows:

Bolitoglossa colonnea (Dunn)
Bolitoglossa occidentalis Taylor
Bolitoglossa helmrichi (Schmidt)
Bolitoglossa rufescens (Cope)
Bolitoglossa dofleini (Werner)
Bolitoglossa mulleri (Brocchi)
Bolitoglossa platydactyla (Cuvier)
Bolitoglossa salvinii (Gray)
Bolitoglossa flaviventris (Schmidt)
Bolitoglossa lignicolor (Peters)
Bolitoglossa yucatana (Peters)
Bolitoglossa mexicana Duméril and Bibron
Bolitoglossa odonnelli (Stuart)
Bolitoglossa borburata Trapido

The following species are tentatively referred to the genus:

Bolitoglossa schmidti (Dunn)
Bolitoglossa altamazonica (Cope)
Bolitoglossa peruviana (Boulenger)
Bolitoglossa ahli (Unterstein)
Bolitoglossa paraensis (Unterstein)
Bolitoglossa striatula (Noble)

Save for Noble's (1921) figure of "*Oedipus adspersus*" and his statements regarding the same, the skeletal anatomy of this second group of species is unknown to me. Noble's figure shows that the prefrontal bone as absent in *adspersus*. He states: "Very marked differences in the anterior cranial elements distinguish *adspersus* and

PLATE XIV

FIG. 1. ? *Magnadigita macrinii* (Lafrentz). Hand and foot. AMNH, No. 6240; San Pedro Alta, Oaxaca.

FIG. 2. *Magnadigita englehardti* (Schmidt). Hand and foot. EHT-HMS, No. 27276; Volcan Atitlan, Guatemala.

FIG. 3. *Magnadigita rostrata* (Schmidt). Hand and foot. EHT-HMS, No. 27285; above Teepan, Guatemala.

FIG. 4. *Magnadigita robusta* (Cope). Hand and foot. USNM, No. 37773, La Palma, Costa Rica.

FIG. 5. *Magnadigita nigroflavescens* (Taylor). Hand and foot. EHT-HMS, No. 27263; Cerro Ovando, Chiapas.

FIG. 6. *Magnadigita lincolni* (Stuart). Hand and foot. UMMVZ, No. 89109; Monte at Salquil Grande, El Quiché, Guatemala.

FIG. 7. *Magnadigita franklini* (Schmidt). Hand and foot. EHT-HMS, No. 27274; Volcan Atitlan, Guatemala.

FIG. 8. *Magnadigita flavimembris* (Schmidt). Hand and foot. EHT-HMS, No. 27272, Volcan Tajumulco, Guatemala.

PLATE XIV

striatulus from *leprosus*. *Oedipus variegatus*, the type of the genus, is so closely allied to *O. striatulus* that it seems probable that these cranial patterns will be shown to be the same. The following characters common to *O. striatulus* and *O. adspersus* may be considered the distinguishing features of the *Oedipus* as now defined [by Noble]: "(1) no prefrontal; (2) no septomaxilla; (3) premaxillae ankylosed only at their extreme anterior ends."

From this one is led to believe that the prefrontal bone is absent also in *striatulus* and *variegatus* [= *B. platydactyla*] Cuvier. However, the prefrontal actually is present in the two latter species. I have not examined the former.

If Noble is correct in the identification of the specimen which he figured as *Oedipus adspersus*, there is very considerable doubt that the species belongs to any of the genera here defined.

The genus will doubtless eventually be divided into two or more subgenera. The most obvious division is between the larger, long tailed species, represented by *platydactyla*, and small short-tailed forms represented by *rufescens*.

The range of *Bolitoglossa* is along the eastern lowlands of México (to 3,500 ft. elevation) from eastern San Luis Potosí south through Central America and into South America.

Representatives of two groups of the genus occur in México.

Platydactylus has been traced to the north along the eastern lowlands as far as San Luis Potosí. East and south of the isthmus *mexicana*, *flaviventris* and *yucatana* occur. Two Mexican forms belonging to the group of smaller species are known. *Rufescens*, a toothed species, has a range similar to *platydactyla*. In the Pacific drainage south of the isthmus it is replaced by a closely related, toothless, species, *occidentalis*.

Representatives of the genus have been traced to the mouth of the Amazon in Brazil. The extent of the range of the genus in South America depends upon the final disposition of species tentatively referred to it.

The validity of the genus *Eladinea* Miranda-Ribeiro is in question. It was erected for a species described from embryos and newly hatched young, from the Utinga forest, Pará, Brazil, which he believed was different from other South American species in being oviparous. Parker (1939) believes that it may be the young of *Oedipus altamazonicus*. However it would be extremely difficult to draw a generic distinction on very young specimens. Neither Parker nor Miranda-Ribeiro have considered the possibility of a relationship with Unterstein's lowland forest species, *Oedipus paraensis* from Santa Isabel near the city of Pará (Belem), Brazil.

PARVIMOLGE genus novum

Genotype *Oedipus townsendi* Dunn

Characters. Diminutive salamanders, characterized by a series of much enlarged dorsal glandules arranged irregularly on each side of the median dorsal line. Skull well ossified; pleurodont teeth on maxillae; paravomerine teeth on parasphenoid in a single patch (2 very closely approximate series); frontal processes of premaxilla arising separately, very close together, not fused or sutured posteriorly; prefrontal absent; carpals and tarsals cartilaginous; phalanges normal; anterior part of centra cylindrical, acoelous, but lacking rounded anterior condyles; no orbitolabial groove; fingers and toes fleshy, syndactylous, with the tips of the three middle toes and the outer fingers free and pointed rather than rounded; a sublingual fold present. (For foot type see pl. XV, fig. 2.)

Skeletal characters of Parvimolge townsendi (Dunn). The prevomers are closely approximated medially but not sutured, save posteriorly; the premaxilla bears seven teeth; the frontal processes, arising from an elevation on the upper part of the base premaxilla, very closely approximated and continuing close together to the frontals and enclosing a narrow fontanelle; frontals and parietals form a straight median suture. Otic capsule well ossified; the orbitosphenoid sutured to the parietal and frontal, the optic foramen large; mandible largely cartilage with one small and four or five very large teeth (at least in the male), extending above the level of the jaw a distance equal to the height of jaw itself. Vertebrae, 15 anterior to the sacrum; atlas not strongly modified, except that the body of the vertebrae is only a little longer than the "odontoid" articulating process. Body vertebrae lacking dorsal crests or spines; no lateral wings behind the transverse processes.

Referred species. Only the genotype, *Parvimolge townsendi* (Dunn).

Remarks. This species lives in the same general region where *Thorius pennatulus* Cope occurs and is of about the same size. It may be readily distinguished from members of that genus, by the absence of the orbitolabial groove, the greater degree of cranial ossification, the enlarged dorsal glandules, the presence of the maxillary teeth, frontal processes of premaxillary not in contact with the prevomerine suture, prevomers forming a continuous suture, and the presence of cartilaginous carpals and tarsals.

Specimens from Guerrero, Hidalgo, which Dunn associated with *P. townsendi* as paratypes, belong in a different genus. These are

PLATE XV

FIG. 1. *? Oedipina complex* (Dunn). Hand and foot. AMNH, No. 40473; Barro Colorado I., Panamá.

FIG. 2. *Parvimolge townsendi* (Dunn). Hand and foot. EHT-HMS, No. 26562, paratype; Jalapa, Veracruz.

FIG. 3. *Bolitoglossus* ? sp. Hand and foot. AMNH, No. 10339; Bogotá, Columbia.

FIG. 4. *Bolitoglossa occidentalis* Taylor. Hand and foot. EHT-HMS, No. 24049, paratype; Finca Juárez, Chiapas, México.

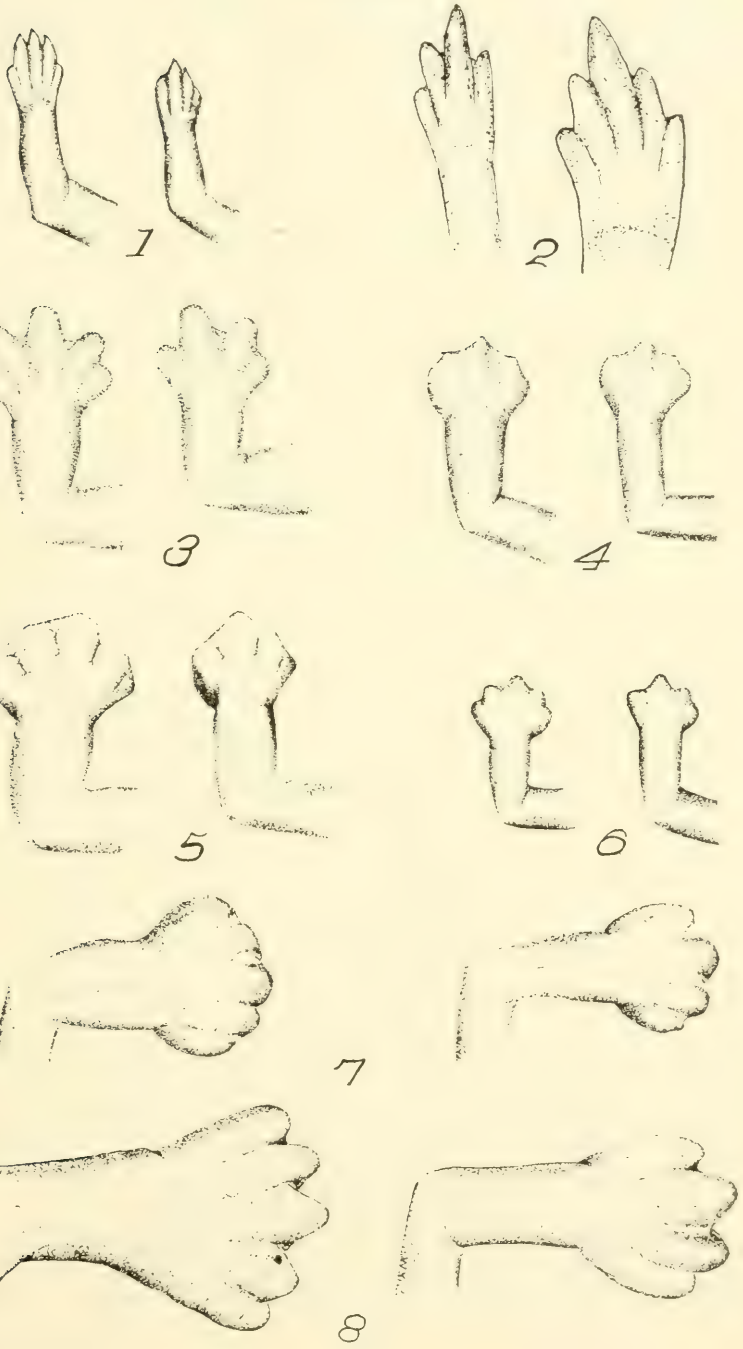
FIG. 5. *Bolitoglossa mexicana* (Gray). Hand and foot. AMNH, No. 45339; Cofradia, Honduras.

FIG. 6. *Bolitoglossa helmrichi* (Schmidt). Hand and foot. EHT-HMS, No. 27053; near Samac, west of Coban, Guatemala.

FIG. 7. *Bolitoglossa flaviventris* (Schmidt). Hand and foot. EHT-HMS, No. 3995; Tonalá, Chiapas.

FIG. 8. *Bolitoglossa platydactyla* (Cuvier). Hand and foot. EHT-HMS, No. 15202, near Córdoba, Veracruz.

PLATE XV



Chiropterotriton dimidiata Taylor. This form may be readily distinguished by hand and foot form, the presence of a prefrontal, no enlarged dorsal glandules on the back, etc., etc. Both have enlarged nostrils.

OEDIPINA KEFERSTEIN

Genotype *Oedipina uniformis* Keferstein

Characters. Elongate, slender-bodied terrestrial salamanders, the tail longer (usually very much longer) than head and body; digits largely or entirely syndactylous, the tips more or less pointed; a sublingual fold; 16 or more vertebrae preceding the sacral vertebrae, all with broad elongate alar expansions on the sides behind the transverse processes; no dorsal crests on body vertebrae, and no lateral spines on ventral or lateral part of centra.

Premaxilla somewhat ossified, rather narrow, rectangular; the frontal processes arising from a common elongate stem, and separated only narrowly; teeth on maxilla pleurodont; a prominent maxillary shelf; paravomerine tooth groups juxtaposed, appearing as a single patch; no orbitolabial groove.

Characters of Oedipina lineola Cope. Maxilla ossified, the teeth pleurodont, increasing in size toward premaxilla; premaxilla with two enlarged teeth in males, 1½ times as wide as high; orbitosphenoid forming sutures with parietal and frontal, widening a little in the middle; optic foramen relatively very small, about one-fifth the width of the bone on a level with the foramen; the paravomerine tooth series on the parasphenoid are very closely approximated, appearing as a single group; frontals and parietals ossified, forming a straight, median suture; carpals and tarsals cartilage; a fontanelle present.

The feet and hands have the basal part of the digits grown together but the two middle fingers and three middle toes are free for some distance; the toes are bluntly pointed. In the adult the tail is twice the length of head and body.

Referred forms. The following species are referred to this genus: *Oedipina uniformis* Keferstein, *Oedipina lineola* (Cope), *Oedipina complex* (Dunn), *Oedipina elongata* (Schmidt), *Oedipina parvipes* (Peters), *Oedipina collaris* (Stejneger), *Oedipina alfaroi* (Dunn). See comment below.

Remarks. There is some doubt whether all the elongate wormlike forms of Central and South America are congeneric with *uniformis* and *lineola*. The skeletal characters of most of the group are unknown and there is a probability that an examination of the skele-

tons will prove that more than a single genus is represented. The more obvious external and dental differences of the seven forms are here shown. Grouped according to the presence or absence of maxillary teeth they may be separated as follows:

Maxillary teeth		No maxillary teeth
uniformis	*elongata*	*alfaroi*
lineola	*parvipes*	
complex	*collaris*	

When grouped according to snout shape the groups are as follows:

Blunt snout	Sharp snout
uniformis	*parvipes*
lineola	*collaris*
complex	*alfaroi*
elongata	

The absence of teeth may not be a generic character, but with few exceptions in amphibians, teeth are present in a given genus, or invariably absent in another. One exception to this in the plethodondids is recognized in the genus *Bolitoglossa: Bolitoglossa rufescens* is without, *Bolitoglossa occidentalis,* with maxillary teeth; *Bolitoglossa colonnea* is without maxillary teeth while the related Bolitoglossa *striatula* has them. An examination of the external and skeletal characters of the first pair of species show them to be very closely related.

The foot character of a specimen from Barro Colorado Island, identified as *Oedipina parvipes,* is different from *lineola* in that the digits are more entirely grown together; the toes are flattened and only the middle toe and the two middle fingers have the tips free; the digits for the most part terminate in sharp points.

This specimen has 17 costal grooves, the hind legs reaching about the length of four and one half costal folds, the arm, four folds, the digital tips being separated by six and one-half folds.

As now known, the genus *Oedipina* extends from central Veracruz south through Central America into northern South America.

Only *Oedipina lineola* is known to occur certainly in México; and as far as collections go it seems to be confined to the low mountain slopes in western central Veracruz. The specimens collected have been found chiefly in piles of chips, and under trash on the ground in the coffee and banana plantations.

The placing by Dunn of *Spelerpes (Oedipus) infuscatus* Peters (having 14 costal grooves, and purporting to come from Haiti) as a questioned synonym of *lineolus* may be warranted since *lineola* is

known to have 14 costal grooves and 13 costal folds. However, comparing the description of *infuscatus* with a specimen of *lineola* of the same size, (21 mm. snout-to-vent) the following differences obtain: Head width (2.48 mm.) in snout-to-end-of-vent length (21.2 mm.) 8.5 times, instead of 7 times. The arm reaches about half the distance between arm insertion and the corner of the mouth, instead of "almost to the corner of mouth;" the hind leg reaches forward beyond the middle of the 11th costal fold. Specimens of *lineola* of this size have the nostril still large, a character not noted in the description of *infuscatus*. The original description is very brief, and other differences may actually obtain. That *Spelerpes infuscatus* is a synonym of *Oedipina lineola* is not established beyond a doubt.

THORIUS COPE

Genotype *Thorius pennatulus* Cope

Characters. Very diminutive salamanders; tongue free with a sublingual fold present; a deep orbitolabial groove, running from eye diagonally back to lip; digit fused together at bases, the middle digits somewhat widened and rounded, and free at tips. Skull poorly ossified, the parietals not forming a median suture, separated by a membrane; orbitosphenoid widely separated by membrane from parietal and frontal; maxilla edentulous; mandibular and prevomerine teeth present; operculum with a minute columella fused to it; premaxilla single, very small, triangular, bearing from 1-3 teeth in males, the frontal processes arising from the base, separately, then apparently suturing, or at least continuing side by side to dorsal surface of skull where they again separate; processes in contact with prevomers along their mutual suture, thus completely separating the nasal capsules by bone; orbitosphenoid nearly rectangular, the optic foramen occupying one third of its width; paravomerine teeth on the parasphenoid in two closely approximated groups (appearing as a single-heart-shaped group); lower jaw well ossified; atlas greatly shortened, the "odontoid" articular process nearly as long as remainder of vertebrae; vertebrae completely opisthocoelous, the anterior part of centrum with a rounded condyle, lacking wings posterior to the transverse processes; 15 vertebrae precede the sacral vertebra; nostril large, varying from very large to moderately large in various species, carpals and tarsals ossified; none or but a small anterior fontanelle between frontal processes of the premaxillae.

Referred species. In addition to the genotype, *Thorius pennatulus*

Cope, the following four: *Thorius dubitus* Taylor, *Thorius troglodytes* Taylor, *Thorius narisovalis* Taylor, and *Thorius pulmonaris* Taylor.

Remarks. These diminutive salamanders are terrestrial. None have been found above the ground save that *Thorius narisovalis* occurs under the bark of fallen trees. Some of the species have the habit of coiling in a flat spiral. The presence of strongly ossified carpals and tarsals, and the deep groove from eye to mouth, separate these from all other genera in Mexico having a nasolabial groove. Apparently there are eight tarsals present. The five species known have a limited distribution in central western Veracruz, and in Oaxaca. A sixth and undescribed species occurring in northeastern Puebla has the nostril reduced in size. *Pennatulus*, occurring between three and four thousand feet elevation, is the smallest species; *Thorius narisovalis*, the largest species, occurs at still higher elevations, some up to 10,000 feet. I suspect that the genus has a much wider distribution than is known at present.

The skull shown by Cope, pl. XXXVII, Bull. 34, U. S. Nat. Mus., purporting to be *Thorius pennatulus*, is not the skull of any of the species of *Thorius* which I have examined. I strongly suspect that some error is involved. The presence of teeth on the maxilla, the much enlarged vomerine teeth, the absence of spines on the premaxilla, the suture of the frontal with the orbitosphenoid, all point to some other species, belonging to another genus.

The figure given by Boulenger (Catalogue of the Batrachia Gradientia s. Caudata and Batrachia Apoda in the collection of the British Museum, 2d Ed., 1882, p. 79, pl. III, fig. 2), is a species of some Mexican salamander which probably does not belong in this genus. The head is thick and there is no orbitolabial groove shown. The "dark lateral band white margined above," also suggests a species that is not a *Thorius*. It is very difficult to say what species is intended.

HAPTOGLOSSA Cope

GENOTYPE *Haptoglossa pressicauda* Cope

Characters. "Tongue adherent in front and by the middle; digits not distinct, four anterior, five posterior; vertebrae opisthocoelous; carpus and tarsus not* ossified."

Remarks. Dunn has synonymized *Haptoglossa pressicauda* with

* Cope may have intended to write "not cartilage" instead of not ossified, since the genus *Thorius* of his family THORIIDAE (THORINAE) with which he compares it has ossified carpals and tarsals.

Oedipus uniformis with the following comment. "Cope's *Haptoglossa pressicauda* is probably the present form. The type has been destroyed. The proportions, dentition, color, and indeed everything except "the tongue adherent in front and by the middle are so like those of young *uniformis* that I cannot help thinking they are the same. I include it in the synonymy with a query."

Cope in his description states that "This genus is of much interest as the first one discovered in Tropical America in which the tongue is not boletoid in form," and points out that "It seems also that the relation of this form of the western coast to those of the east coast of this group is the same in Costa Rica as that which prevails in North America. It is well known that no species of salamander, with a boletoid tongue, is found on the Pacific coast of North America." Since Cope has used the character of the attached tongue for the above comment, it seems very unlikely that his statement "tongue adherent" is a lapsus or due to faulty observation.

The species is a short tailed form, "Length of tail equals that of body without the head. Tail compressed from near base to apex, with a median dorsal but no ventral groove, and well-marked vertical grooves." Cope also points out that the species resembles *Thorius* and *Oedipina*, but that it differs from these latter in the shorter, compressed tail, as well as in the generic characters listed.

Since no species of *Oedipina* (or of *"Oedipus"*) is known to have the tongue adherent, I believe Dunn's action in placing this form in synonymy, even with a question mark, wholly unwarranted. That the species has not been rediscovered is not surprising, since diminutive forms are very secretive, and special effort is necessary to find them.

SPECIES INCERTAE SEDIS

Two species, referred by Dunn (1926) to his genus *Oedipus*, *Spelerpes picadoi* Stejneger, and *Spelerpes sulcatum* Broochi, have not been referred to any of the genera defined here. Specimens of the former which I have been able to examine are in such a state that I cannot be certain of their affinity.

To the best of my knowledge no specimens of *Spelerpes sulcatum* save the type series are in collections. The final disposition of this species must await an examination of the type, and a study of the internal anatomy of the species.

NOTE.—Part II of this paper (to be published later in this journal consists of a comparative anatomical study of species of the various genera delineated here.

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CONTENTS OF VOLUME XXX, PART II

NUMBER		PAGE
13.	Scientific contributions published by members of the University of Kansas from January 1, 1943, to June 30, 1944. Compiled by *Homer B. Latimer*	235
14.	The Environment, Life History and Structure of the Water Boatman, *Ramphocorixa acuminata* (Uhler) (Hemiptera, Corixidae). *Melvin E. Griffith*	241
15.	Revision of Nearctic Bibionidae Including Neotropical *Plecia* and *Penthetria* (Diptera). *D. Elmo Hardy*	367
16.	The occurrence of *Eucastor* and *Epigaulus* in the Lower Pliocene of Trego County, Kansas. *Claude W. Hibbard* and *Lester F. Phillis*	549

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXX, pt. II.] JUNE 15, 1945 [No. 13

List of Publications from the Science Departments from January 1, 1943, to June 30, 1944

Compiled by HOMER B. LATIMER

THE University of Kansas Science Bulletin has published many papers and yet these papers are but a very small part of the total number of research papers published from the science departments. It was the feeling of the Science Bulletin Committee that a complete listing of all research papers from the various departments would be desirable, and in accordance with the instructions of the Committee, the following list of papers has been prepared. A circular letter was sent to all science departments asking for titles and references and we hope that we have listed correctly all papers which should have been given in this list.

BEAMER, R. H. 1943. Some new species of Typhlocyba (Homoptera, Cicadellidae). Canadian Entomologist, 75, 132-133.

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COLLINS, CAROLYN. (see Sherwood, Noble P.).

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The Environment, Life History and Structure of the Water Boatman, *Ramphocorixa acuminata* (Uhler) (Hemiptera, Corixidae)*

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ABSTRACT: *Ramphocorixa acuminata* (Uhler) is particularly successful and widely distributed in the prairie pond environment of middle-western, south-western, and Mexican plains. The one companion species in the genus, *R. rotundocephala* Hungerford, is found in México and the Greater Antilles. The habit of laying eggs upon crayfish has long provoked interest and debate; protection from drought and enemies, aëration, and convenience are factors discussed in connection with the curious preference shown in oviposition. The life cycle phenomena—eclosion, growth, exuviation, self-maintenance, mating, oviposition—are described from the field and laboratory, with notes on the diet, associates, pests and predators of the water boatman. The work closes with an illustrated discussion of the skeletal structure and its homologies.

CONTENTS

PAGE
Preface 243
PART 1. ENVIRONMENT, HISTORY AND DISTRIBUTION 244
The Pasture Pond 244
Conditions 244
Seasons and Biotic Requirements 245
The Pond Community 245
Historical Synopsis (1876-1940) 251
Distributional Notes 256
PART 2. THE LIFE OF THE WATER BOATMAN 261
Some Aspects of the Study 261
The Corixid-Crayfish Association 263
Three Theories 263
The Egg 264

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PAGE
The Crayfish 267
Preferences in Oviposition 268
Limitations of Theories 272
The Factor of Convenience 273
The Life Cycle in Ponds 275
Eclosion 280
The Instars 282
Descriptive Notes 282
Growth in Aquaria 284
Exuviation 288
The Corixid Diet 290
Pests and Predators 292
Observations in the Aquarium 293
Self-maintenance 293
Mating 296
Oviposition 297
PART 3. THE SKELETAL STRUCTURE OF THE WATER BOATMAN 298
The Cephalic Skeleton 299
The Cranium 301
The Rostrum and Ingestive Structures 305
The Thoracic Skeleton 311
The Cervix 311
The Prothorax 312
The Pterothorax 314
The Thoracic Appendages 319
The Abdominal Skeleton 324
The Visceral Region 324
The Genital Region 327
Literature Cited 329
List of Abbreviations 336
Plates 338

PREFACE

THE objectives of this experimental essay on the life and structure of our most interesting species of water boatman are those of any introductory study—to inform and to stimulate. It is hoped accordingly that the deficiencies in the first objective may bring the compensation of an added impetus toward the second. The success of an introduction depends measurably upon the future acceptance of the challenge in the problems suggested or imperfectly solved. Though an extension of this work is intended, the conclusion must be written in the critical appraisal of other students, to whom I heartily commend the profitable exercise in appreciative thought which any species successfully meeting the problems of its environment must deservedly arouse.

May others enjoy as generous assistance and kindly indulgence as has been granted me. I wish to express sincere appreciation for the facilities provided, the time and thought expended, and the forbearance shown by all members of the University of Kansas Department of Entomology—Doctors P. B. Lawson, K. C. Doering, R. H. Beamer, L. C. Woodruff, and particularly Dr. H. B. Hungerford, whose ever-helpful enthusiasm was an unfailing inspiration and encouragement. Dr. H. H. Lane, Dr. W. J. Baumgartner, and others of the Department of Zoölogy, assisted with suggestions and special apparatus. The Harris crayfish collection was resurrected for me by Mr. C. D. Bunker. The University of Michigan Biological Station made available the opportunity for collection and study of valuable morphological material. Dr. Philip Levereault gave many helpful suggestions upon fundamental morphological interpretations and the preparation of the plates. Dr. A. D. Whedon provided facilities and suggestions for making the microscopic slides recently of much service in checking conclusions of the gross dissections. Mr. Robert Guntert demonstrated the possibilities of aërated aquaria in rearing aquatic Hemiptera, and gave ready assistance on many occasions. Dr. Robert Polson cheerfully aided on field trips in all seasons. The University of Minnesota Library has been most courteous in lending periodicals recently, and my wife, Pauline Bogart Griffith, has loyally assisted in preparing photostat abstracts. With these co-workers and all other contributors, I wish to share the best in this work, reserving the responsibility for its errors.

PART I—ENVIRONMENT, HISTORY AND DISTRIBUTION

"Whatever ideas the different branches of biological science may accumulate the ultimate object is to discover how the different entities of the biological world are related with one another."—Maulik (1939).

THE PASTURE POND

CONDITIONS

In Kansas there are several thousand pasture ponds, more than one hundred in Douglas county. These numbers are typical of similar areas in the Middle West. Some of the ponds are natural pools —the wallows, water holes, sinks and oxbows of the prairie. Others are impounded waters in shallow, scooped-out basins and intermittent stream beds, retained by indifferent embankments or permanent dams, and fed by ground waters or the watershed. These ponds are usually ovate, narrower toward the source, and rarely more than several hundred feet in circumference or five feet in depth. They are constantly menaced by erosion and evaporation, though persistent marginal trampling by livestock often discourages the encroachment of plants.

The short history and irregular fluctuations of the average western pond are not conducive to satisfactory generalizations. Wide variations in water level, turbidity and temperature are reflected in light penetration, photosynthesis, decomposition and other factors conditioning the dissolved gas content and the productivity. For example, one small, muddy stock pond in Douglas county, evaporating at high surface temperatures (104° F.) and filled with dying and decaying organisms, cleared perfectly two weeks later (Aug. 14, 1941) following rains, with renewing population, abundant algal growth, and oxygen near saturation (at 88° F.).

The water is often crowded with organic material and the bottom covered with fine debris, easily disturbed and slow to settle. Absence of wind action and currents may be followed by surprising temperature and chemical stratification. Slight alkalinity seems the rule in all seasons, though pH 6.6 to pH 8.2 has been recorded in Douglas county ponds. This agrees with the results of Eddy (1934) in Illinois. The general physical, chemical and ecological aspects of pond environments have been discussed by Shelford (1911, 1937), Chapman (1931), Welch (1935) and Pearse (1939), with excellent bibliographies.

SEASONS AND BIOTIC REQUIREMENTS

The pasture pond is an essentially isolated and characteristic environment of the western plains, receptive to particular species and communal life—though haphazard disturbances by livestock, unpredictable seasonal misfortunes, and other factors of variability and impermanence may affect representative ponds. Those in this region are often the vernal-autumnal type. The wakening abundance of spring is followed by the hard restrictions of summer drought. The turmoil of struggle for preservation is cramped and desperate as the water subsides to barren mud. Revival comes with autumn rains, but these are followed by the ordeal of winter freezes.

Individually and racially, all pasture pond organisms must pass certain entrance requirements for admission to select standing in this difficult regime. Emphasis falls on adaptability (cf. Shelford's "flexible mores," 1911), energy and endurance. Each organism must fit into the conditions, find the requisite foodstuffs, withstand the rigors of climatic extremes, respond quickly in brief, favorable periods, and defend itself effectively. Each species must be prolific, the life cycle fitted snugly with seasonal changes and the available facilities for reproduction and growth. Jewell (1927) suggested short life and semiaquatic habit, or resistance to extreme conditions, if permanently aquatic, as chief characteristics of prairie pond animals. Chapman (1931) stressed the high biotic potential of the pond fauna.

Even temporary ponds usually teem with life. Mozley (1932), in his study of such a pond in Western Canada, suggested that alternation of moist and dry conditions has an important part in the high productivity. A functional, if imperfect, state of balance is an immediate requirement. Plants must be available to herbivores—the latter in quantities sufficient both to themselves and to the predators. A thoroughgoing account of pasture pond inhabitants is impracticable here, but some representative forms and their interrelationships may be considered.

THE POND COMMUNITY

Vegetation. Stock ponds are rarely encouraged to fulfill their possibilities as water gardens, though nature sometimes manages it without assistance. Usually conditions and appearances remain fitting the purpose of the water hole or wallow. Some few ponds are shaded by trees, and support the tall stems of bur reed, sweet flag and cattail. Pondweed, water plantain, arrowhead, water lily and

duckweed may also occur. The larger vegetation is not typical; the shallow plains ponds are too often remote from other waterbodies, easily subject to seasonal disaster, and puddled by livestock which mutilate and destroy the growing plants. Thus obvious and important advantages may be lost in food, shelter, variety, dissolved gas balance, and productive debris.

Vertebrates. Killdeer and other shore birds patrol the pond margins in search of insects. Border plants, infrequently present, attract nesting redwing blackbirds and others. Doves and martins are frequent visitors near habitations; in distant or sheltered ponds, ducks and herons are seen occasionally. Near wooded areas, the soft shore mud may bear testimony to visits of opossum and raccoon, perhaps interested in the frogs, often numerous. Snapping turtles are occasional residents, painted turtles less common. Catfish, perch and minnows are sometimes introduced, but rarely fare well; improper food supply, confinement and impure water are usual disadvantages. Jewell (1927) includes the penitentiary minnow in the characteristic original prairie pond fauna. Tiger salamander larvae are sometimes surprisingly abundant in North Dakota permanent ponds and lakes. Vertebrates are the more spectacular members of the carnivorous pond fauna, wherever they occur, but in real significance are limited to instances of unusual abundance.

Microscopic Life. Algae and Protozoa form that essential subcommunity which basically supports much of the larger pond association. In mats and scums, masses on the bottom, or staining the whole water-body, these minute plants and animals may reach prodigious accumulations in warm, evaporating ponds. The usual condition is more than enough to supply the pond floor grazers (p. 250) fed upon by the predators.

The algae are particularly varied and numerous. The gold and crystal diatoms form spindles and wedges (*Navicula, Pinnularia, Gomphonema, Surirella*), sometimes asymmetrical (*Cymbella*), sinuous (*Pleurosigma*), arranged in wheels (*Asterionella, Meridion*) and chains (*Tabellaria, Fragilaria*). The blue-greens are present as platelike and spherical colonies (*Merismopedia, Coelosphaerium, Oscillatoria*), and beaded strings, free or colonial (*Anabaena, Rivularia*). The chlorophyll-green algae are represented by lobular and spindle-form desmids (*Cosmarium, Netrium*), filaments (*Zygnema, Spirogyra, Mougeotia*), flagellates (*Chlamydomonas, Pleodorina*), and colonies of spores (*Sphaerocystis, Tetraspora*), crescents (*Selanastrum*), regular plates (*Scenedesmus*) and scum-forming nets

(*Hydrodictyon*). The variety and interest of the pond algae, added to their importance as food manufacturers and reservoirs, make these humble plants an attractive subject for expansion (Thompson, 1938).

The Protozoa, though usually less numerous and essential than the algae, are more actively individual and with many absorbing similarities to higher animals in problems and reactions. Slow-flowing amoeboids—naked (*Amoeba*) or with shells (*Arcella, Difflugia*)—are not as evident or challenging as the scurrying flagellates and ciliates. Individuals of the latter largely retain the basic compressed ovate or cylindrical shapes (*Euglena, Phacus, Anisonema, Notosolenus, Trichoda, Paramoecium*); notable variations among the infusoria are barrel-like (*Coleps*), long-necked (*Trachelophyllum*), trumpet-shaped (*Stentor*), and bushy forms (*Cyclidium, Stylonychia*). Flagellate colonies are commonly free-swimming, in clusters (*Gonium*) and scalloped plates (*Peridinium*). Stalked ciliate individuals (*Vorticella*) and branching colonies (*Zoethamnium, Opercularia*) are often attached on plants, molluscs, crayfish, insects and turtles.

In addition to the microscopic plants and animals, bacteria—helped on by the high mortality in pasture ponds and the usual uncleanliness—swarm in the waters and bottom debris. In the productive pond community, these three large groups of miniscule organisms—algae, protozoa, bacteria—are interoperative in the all-important spheres of food manufacture, energy storage, decomposition, and the maintenance of dynamic reserves.

Invertebrates. Most animal phyla are represented, when the pond conditions meet their requirements. Fresh-water sponges, hydras and bryozoans are occasional in clearer ponds. Flat-worms and round-worms, rotifers, oligochaetes (*Tubifex*) and leeches (*Placobdella*) are generally plentiful. None surpasses the Crustacea in numbers and constancy; swarms of cladocerans (*Daphnia, Bosmina*), copepods (*Cyclops*), phyllopods (*Eubranchippus, Apus, Estheria*) and ostracods (*Cypris*) occur frequently in freshened waters. Jewell (1927) reported these groups in large numbers in spring and fall, but practically absent in midsummer, and found phyllopods most characteristic in prairie ponds. Mozley (1932) also mentioned the fairy shrimp (*Eubranchippus*), pointing out (cf. Shelford, 1919) that the eggs must be dried and frozen before hatching. Crustacean "nauplius" stages are found in the plankton. Isopods (*Asellus*) and crayfish (*Cambarus*) are numerous. The latter

seem often the most actively voracious members of the larger pond fauna. Snails (*Planorbis, Physa*) and clams (*Anodonta, Pisidium, Sphaerium*) are regularly present, increasing with pond permanency and plant growth. Water-mites are common, the young often attached to insects.

That last ubiquitous group of invertebrates, the Insecta, is well-suited by the usual winged condition and singular hardiness to its position of importance in pasture ponds. Some insects are incidental —the inveterate beach-combers of every water body. Butterflies, bees, potter-wasps, and tiger beetles are hurried visitors, with swarms of midges and other flies. Ground beetles (*Bembidium*), shore bugs (*Saldula*) and springtails (*Isotoma*) course over the shore. Mud-loving beetles (*Heterocerus*) and mole crickets (*Gryllotalpa*) occasionally burrow in untrampled marginal areas. The true, resident aquatic insects are not necessarily peculiar to the pasture pond, but must show—individuals and species—the qualities for entry, maintenance and rehabilitation required by that environment (p. 245).

Surface Insects. In fresh ponds with plant growth, knobby and globose Collembola (*Podura, Bourletiella*) often pepper the marginal surface with tiny bodies. The springtails seem attracted by floating plant fragments, perhaps feeding on the adherent microscopic life. They are known to submerge and are thought to hibernate on the bottom, rising with the first hint of spring. Though fragile in appearance, the springtails display hardiness and agility equal to weather changes and probable surface raiders.

Whirligig beetles (Gyrinidae: *Dineutes, Gyrinus*) circle dizzily on ponds of all conditions, usually in large schools preying on insects fallen on the surface and scattering or diving when threatened. The gyrinid larvae—pale recluses on the bottom—are rarely seen. They are provided with lateral abdominal gills, and apical abdominal hooks draw them backward. Though predacious, they will accept vegetable material. Fully developed larvae ascend plants and construct pulpy cocoons. The adults appear in late summer; many die in the fall, but others overwinter in the mud banks, easily drawn out by warm weather. Gyrinidae are adept fliers, widely distributed in most fresh waters.

Water striders (Gerridae: *Gerris, Rheumatobates*), though awkward off the water, reach many ponds. The gerrids often skate swiftly in large groups, in search of emerging midges, fallen leafhoppers, and like prey. The life cycle is passed on the water surface,

where frisking nymphs hatch from the eggs laid on floating grasses and other supports. In the winter, the adults find shelter in the mud banks; the problem of summer drought is more difficult. Survival and increase are likelier on permanent ponds.

Pond Predators. Free-roving, predacious pond insects are best exemplified by the diving beetles (Dytiscidae). These generally range in number and frequency in inverse proportion to their size; the smaller species (*Laccophilus, Hydroporus*) are more often numerous than the medium-sized (*Coptotomus, Colymbetes, Acilius, Thermonectes, Eretes*), and the larger (*Dytiscus, Cybister*) are few. This seems fortunate with respect to their voracious appetites. Molluscs, dragonfly naiads, other insects, and even small tadpoles are representative prey—drained through the grooved mandibles of the beetles. The fierce larvae are appropriately called water-tigers; some (*Coptotomus*) are provided with tracheal gills, but others must secure air at the surface through anal tubes.

Water scavenger beetles (Hydrophilidae) are in part predacious, similar to the preceding family in habit and distribution, though some species (*Berosus*) are vegetarian. The larvae of these remain submerged, having lateral gill filaments, and feed on the algae. The larger carnivorous species (*Hydrophilus*) are not uncommon, while the medium-sized shiny black forms (*Tropisternus*) are among the most typical pasture pond residents. The larvae must ascend to breathe, often dragging other insects aloft to be eaten while the abdomen is thrust out for air. Water scavengers and diving beetles share the advantages of strong flying ability and abundant food supply in the pond environment.

Backswimmer bugs (Notonectidae: *Notonecta, Buenoa*) are the familiar, accomplished assassins of the ponds, with stiletto beaks and multitudes of victims. The nymphs feed on the entomostracans, turning in maturity to insects and tadpoles. The smaller species (*Buenoa*) are often incredibly numerous, constantly dimpling the water in rising for air or surface prey. Migrations may attain the magnitude of "showers." Another predacious bug family (Belostomatidae) is remarkable for the oviposition habit. The males of *Belostoma* carry the eggs on their backs, glued there by insistent females. These bugs are usually in ponds with vegetation, though well distributed by flight.

Some few characteristic predacious insects have aërial adults and aquatic larvae, with obvious advantages in pasture ponds. Glistening representatives of the Odonata—dragon flies (Anisoptera) and

damsel flies (Zygoptera)—course to and fro, hunting small flying insects. In spring, mating couples are in flight. The naiads (*Anax, Plathemis, Tramea, Archilestes*) are particularly important in ponds with vegetation, feeding on entomostracans, insects and snails, seized with the curious extensible labium. In turn, they provide other predators with food. The damsel-fly naiads respire with apical abdominal gill appendages; rectal tracheal gills serve the dragon flies. The latter may inflict painful wounds with spines ringing the anus. The larger naiads of both suborders hibernate in the bottom mud. True flies (Diptera) merit attention here. Horseflies (Tabanidae) are familiar as pernicious blood-suckers; the larvae are also voracious, feeding in the pond mud on insects and snails. The eggs are laid in shining clutches, deposited shingle-fashion on convenient water plants. Phantom larvae (Culicidae: *Corethra,* or *Chaoborus*) prey upon rotifers and entomostracans, seized with the raptorial antennae. They produce mosquitoes which are not blood-suckers.

Pond Grazers. The burden of communal maintenance falls on the herbivores, which must multiply sufficiently for racial security while supplying the predators with food enough to keep them from self-destruction. The pond grazers tap the immense vital reserves in plant life, the algae particularly—and sometimes the intermingled animalcules—and convert them into their tissues which may be used by the carnivores. In this final group, certain insects are representative.

Mayflies (Ephemerida) perform their familiar, fleeting dance above the ponds, especially those with vegetation. The naiads (*Caenis, Siphlonurus*) feed on desmids and diatoms, with occasional tissue fragments from larger plants. They are often abundant and favorite articles in the predatory diet. True flies (Diptera) in this group include the swarms of midges (Chironomidae) and mosquitoes (Culicidae). The bloodworms (*Chironomus*)—well-known as good fish food—are hatched from eggs massed in jelly columns. They feed on algae and decaying vegetation on the bottom, and are found in nearly every water body. The pupae are active, as are the pupae of the blood-sucking mosquitoes (usually *Culex*). The larvae of the latter feed on the microscopic bottom organisms.* Crawling water beetles (Haliplidae: *Haliplius, Peltodytes*) are small and hard-shelled. Both the adults and the inconspicuous larvae feed largely on filamentous algae. The herbivorous water scavengers (*Berosus*) have been mentioned (p. 249).

* *Aëdes* and *Psorophora* are also common, and the surface-feeding *Anopheles* (including the malaria mosquito, *A. quadrimaculatus*) may become abundant in ponds with vegetation and floating debris.

There remains the important group of pond insects which includes the subject of this work—the water boatmen (Hemiptera, Corixidae). These vigorous bugs are the streamlined counterparts of the backswimmers (Notonectidae) in fitness for their habitat and livelihood, reflected in their awesome numbers, wide distribution and fabulous migrations. They are opposed to their predatory relatives in food habits, feeding on a benthic "salad" of algae, protozoans and rotifers, perhaps including entomostracans and tiny insect larvae. In turn, the water boatmen are relished by predacious insects, fish, birds and other enemies.

Spring and fall are high points in the yearly cycle, when nymphs and adults enjoy the opportunities of well-filled, revivified ponds. Representative collections in this region regularly contain many corixids, large and small, with orange-brown bodies and orange-gray-brown pronotum and wings, marked with wavy, transverse lines and splotches (*Corisella, Arctocorixa, Trichocorixa*). Among these are varying numbers, often dominant, of small, lighter specimens with less distinct wing markings, and with the male head acuminate. These individuals are members of our species, *Ramphocorixa acuminata* (Uhler), which lays its eggs on crayfish (Pl. XVI), and thus provoked the attention leading to an introduction to its life and structure as an interesting native of the prairie ponds. It is hoped that it will be found not only in some measure representative of its own kind, but also indicative of the specialization in form and habit of an animal meeting the requirements of a limited environment.

HISTORICAL SYNOPSIS (1876-1940)

The known record of *Ramphocorixa acuminata* (Uhler) rests in the literature of sixty-five years and fifteen authors. It is summarized in this section as the groundwork for the study, and as an entertaining example in the accumulative composition of the written history of an organism, stemming from an interesting practice in its way of life. The several abstracts follow in chronological order; the articles starred (*) are especially recommended for study in connection with this Introduction. Complete references are starred in the bibliography (p. 329).

1876. Forbes, List of Illinois Crustacea: pages 4 and 5.—Corixid eggs were found numerous on *Cambarus immunis* (commonest species of crayfish in central Illinois, especially frequent in muddy prairie ponds) taken from stagnant ponds in midsummer. *Corixa alternata* was suggested as the commoner of two species found in the

ponds, the other being undescribed (Uhler). Preference was noted for the marginal abdomen, with extension along the sides of the cephalothorax sometimes covering the dorsum. Eggs were found only on the crayfish, thought to rescue them from drying ponds by their migratory habits.

**1878. Forbes, Breeding Habits of Corixa:* page 820.—Corixid eggs were found on *Cambarus immunis, C. acutus,* and pond mollusc shells in Illinois. This was considered a provision of nature to guard against the waste of eggs in drying ponds. (See p. 263.)

1897. Uhler, Contributions towards a Knowledge of the Hemiptera-Heteroptera of N. America: pages 392 and 393.—*Corixa acuminata,* n. sp. "Pale smoke-brown, narrow, head much longer than the pronotum in the male, produced anteriorly into an acute point, which forms the apex of a thick carina. . . ." Related to *C. Burmeisterii* Fieber. Central Texas, Northern Illinois.

1904. Crevecoeur, Additions to the List of the Hemipterous Fauna of Kansas: page 234.—*Corisa scutellata* in stock pond. March, October. (See Bueno, 1920.)

**1912. Abbott. A new Type of Corixidae (Ramphocorixa balanodis n. gen. et sp.) with an Account of Its Life History:* pages 113-121.—Corixids were reared from eggs on crayfish, taken from a small clear-water pond near Columbia, Missouri, in the early part of July. Rearing was unsuccessful in small aquaria, but was completed in an aërated, zinc-lined tank, with soft mud bottom and a few water weeds. Hatching began July 8, with molts approximately July 16, July 24, July 31-August 3, and August 10, the adults appearing about August 18. Detailed descriptions were given the egg and the nymphal instars. The adults were described as a new genus and species with particular emphasis on the cleft palae† and acuminate head of the male, the minute strigil, the short lenticular pronotum, and the frontal fovea of the female. General notes on color: "Head yellowish, tegmina pale silvery grayish, almost iridescent in the female, darker in the male, the characteristic vermiculate or banded markings usual in the group nearly obsolete. Pronotum grayish or smoky brown, suffused with darker in the male. Rostrum pale yellowish. Tergum, legs and whole ventral surface of female pure white. Dorsum of male black, except the lateral margins, which are pale, the ventral surface white, except for two broad almost black oblong bands on either side. . . ." Length, 5 to 5½ mm. Fig-

† "Lower edge (of pala) entire, slightly concave; upper surface flat, deeply incised about midway the length, so as almost to cut the pala into two joints."

ures of the egg, nymphal and adult structures. Columbia, Boone county and St. Louis county, Missouri. July and November.

* *1912. Abbott, An unusual Symbiotic Relation between a Water Bug and a Crayfish:* pages 553-556.—Corixid eggs were found on *Cambarus immunis.* It was suggested that distribution of the corixid might be conditioned by the association with the crayfish; that the eggs, with adherent debris, might camouflage the crayfish, while receiving protection from egg predators. (See p. 263.) Photograph of dorsal and lateral views of a crayfish bearing several thousand eggs. Columbia, Missouri; Central Illinois; Texas.

1916. Bueno, Aquatic Hemiptera. A Study in the Relation of Structure to Environment: 362.—Reference to *Rhamphocorixa*‡ *acuminata* feeding on an ostracod, as observed by Abbott, 1912. (Abbott suggested the probable synonymy of his species with Uhler's *Corixa acuminata* in a letter to Bueno, subsequent to the description. Though not definitely published until 1920, the synonymy was accepted in this article and in those by Hungerford, 1917 et seq.)

1917. Van Duzee, Catalogue of the Hemiptera of America North of Mexico: pages 478, 479.—1419. *Ramphocorixa balanodis* Abbott. . . . 1421. *Arctocorixa acuminata* (Uhl.).

1917. Hungerford, Food Habits of Corixidae: page 2.—Reference to Abbott's observations of the larger nymphs of *Ramphocorixa* feeding on ostracods.

1917. Hungerford, Life History of a Boatman: pages 112-115.—Reference to Abbott's rearing experiments in the introduction to this study of an Arctocorixa species. Eggs of *Rhamphocorixa acuminata* were found on crayfish, tin cans and boards, and shells of living snails.

**1919. Hungerford, The Biology and Ecology of Aquatic and Semiaquatic Hemiptera:* pages 211, 212, 215-221, 246-248.—The genus *Ramphocorixa* was defined, with notes on the papers by Abbott, the synonymy of *Ramphocorixa balanodis* and *Arctocorixa acuminata,* and the remarkable sexual dimorphism. The species was described as typically present in muddy, stagnant ponds, probably hibernating there as adults. Eggs were found occasionally attached to sticks and floating plants. The egg positions on the crayfish were tabulated, and discernible preference found for the regions most affected by the currents from the gill chambers. It was suggested

‡ This spelling of the generic name occurs in several articles, evidently considered the more proper transliteration from the Greek. However, the original orthography was *Ramphocorixa.* (See Article 19, International Rules of Zoölogical Nomenclature.)

that these ovipositing sites insured aëration. (See p. 263.) Eggs (on fragments of a crayfish carapace) were placed in a balanced aquarium and adults secured, some being maintained for four months, feeding on the bottom deposits. Figures of areas on the crayfish preferred in oviposition, the egg, and adult structural features. Kansas; Middle West.

1920. Bueno, On Rhamphocorixa balanodis Abbott: page 88.—*Rhamphocorixa acuminata* (Uhler), 1897 (Corixa) = *R. balanodis* Abbott, 1912. Washington, D. C.; Plano, Texas; Normal, Illinois (U. S. N. M., coll. C. V. R., labeled *Corixa scutellata*).

1922. McAtee, A Shower of Corixidae (Heter.): page 88.—A note by the collector, Mrs. A. P. Bigelow, Ogden, Utah, described the descent of a swarm of the water bugs (*Ramphocorixa* and *Corixa*, det. McAtee), August 2, 1921, 9:00 p. m. They were exhausted and dying, and lay in heaps on the ground through the night and the following morning. Light had not attracted them, and there was no unusual wind when they arrived; the frayed appearance of the water boatmen indicated possible encounter with strong winds before arrival.

**1923. Hungerford, Notes on the Eggs of Corixidae:* page 13.—Note was made of the selective deposition of the corixid eggs on crayfish for the aërative benefits of gill currents. Figures of the egg and a crayfish, indicating the preferred areas for oviposition.

1924. Comstock, An Introduction to Entomology: page 362.—*Ramphocorixa acuminata* usually attaches its eggs to crayfish. (Repeated through nine editions to 1940.)

1926. Wellhouse, How Insects Live: page 98.—Mention of the curious habit of a corixid attaching its eggs to the sides of crayfish.

**1926. Blatchley, Heteroptera or True Bugs of Eastern North America:* pages 1065, 1067, 1068.—Full descriptive notes were given for the genus and *Ramphocorixa acuminata*. Eggs on crayfish in June and July. Figures of male pala and the heads of the male and female. Eastland county, Texas.

**1927. Hungerford, A new Ramphocorixa from Haiti:* No. 278. —*Ramphocorixa rotundocephala*. Described from a male, Manville, Haiti, Feb. 6-10, 1922, F. E. Watson (Holotype, Amer. Mus. Nat. Hist.), and two specimens from Cuba. "General color pattern . . . like that of many males of *Ramphocorixa acuminata* (Uhler) that show striping. The dark stripes are more densely pigmented. . . . The head of the male is rounded as viewed from above, not keeled

as in *Ramphocorixa acuminata* (Uhler). . . ." Figures of pala and genital capsule.

1928. Jaczewski, Bemerkungen über die geographische Verbreitung der Corixiden: pages 50, 55, 58, 59, 64.—*Ramphocorixa* was placed among genera of advanced specialization in the Corixinae, probably endemic in the Nearctic Region, though its two species are found in the Nearctic and Sonoran Faunas, from Montana to Haiti and Cuba.

1930. Morgan, Field Book of Ponds and Streams: page 226.—The egg-laying habit of *Ramphocorixa acuminata* was compared with that of *Belostoma*. Notes on the work of Abbott and Hungerford. Eastern Kansas.

**1931. Jaczewski, Studies on Mexican Corixidae:* pages 189, 194-196, 225-227.—Specimens of *Ramphocorixa acuminata* were collected in two Mexican localities on the Pacific slope. The egg collections, taken on *Cambarellus* more than one month later (August) than previously reported in the United States, were considered possibly indicative of more than one yearly generation in Mexico. Additions were made to the descriptive knowledge of the species, particularly the proportions of various structures. The wide area of distribution was stressed. It was suggested that *Ramphocorixa* was originally Sonoran, spreading subsequently eastwards, toward the Atlantic coast of North America, and that *R. acuminata* may be found in more elevated, and perhaps also more arid localities. Notes on the work of Uhler, Abbott and Hungerford. Figures of strigil, central lobe of seventh abdominal tergite, right and left parameres, and forewing. Ocotlan and Tizapan, Jalisco.

1931. China, An interesting Relationship between a Crayfish and a Water Bug: pages 60-62.—Eggs of *Ramphocorixa acuminata (balanodis)* on *Cambarus immunis* and *C. acutus*. A review was given of the explanations of the relationship by Forbes, Abbott and Hungerford, and the true explanation was connected with aëration of the eggs (Hungerford). Figures of egg-bearing crayfish, enlarged egg, and male of *R. acuminata*. Ponds of Mississippi Valley.

1933. Poisson, Quelques observations sur la structure de l'oeuf des insectes Hémiptères-Hétéroptères: pages 29, 31.—The egg of *Rhamphocorixa acuminata* was described as semi-cylindrical and figured. It was noted that "Chez ces Hémiptères aquatiques l'oeuf est fixé à un support (minèral, végétal, quelquefois même à un autre animal aquatique)."

This was, in effect, the last printed record discovered for our water boatman, since the notation in Comstock's text (1940) is the passage from the original edition (1924). There are doubtless many interesting unwritten observations on a species so widely distributed and easily recognized by the marked sexual dimorphism, and with such a curious egg-laying habit. Fairly general acquaintance with the egg masses on the crayfish has been found in conversations in the field, though the supposed identity of the covering has ranged from "moss" to the eggs of the crayfish, itself.

DISTRIBUTIONAL NOTES

In the Francis Huntington Snow Entomological Collections, there are unusually fine series of both species of *Ramphocorixa*. *R. acuminata* is best represented from Kansas and Texas, but is apparently well distributed throughout the Mississippi Valley, with outposts in Minnesota in the North, the District of Columbia and Alabama in the East, Colorado in the West, and extending far south into Mexico (Puebla). New records for *R. rotundocephala* show this species in the tropics of Puerto Rico, and widely distributed through Mexico, reaching into Arizona. The record in Utah (McAtee, 1922) may also apply to this species.

All the localities for *Ramphocorixa acuminata* are in the so-called Austral Region of Merriam. Before proceeding farther, it may be well to recall the division of this Region into particular Zones, as follows:

Zones	Arid (Faunas)	Humid (Faunas)
Transition	Transition	Alleghanian
Upper Austral	Upper Sonoran	Carolinian
Lower Austral	Lower Sonoran	Austroriparian

Localities for *Ramphocorixa rotundocephala* are in the Tropical regions of the Greater Antilles and probably of Mexico, and in the Sonoran faunas of Mexico and Arizona. A faunal list of the specimens of *Ramphocorixa* in the Snow Collections may be of interest and service in discussing the distribution of the genus. The records of *R. acuminata* from the United States are listed under their respective faunas. Those from Mexico belong to the Sonoran, as far as can be ascertained.

Ramphocorixa acuminata (Uhler)

ALLEGHANIAN FAUNA

MINNESOTA. *St. Paul*, Elks Golf Ponds, H. B. Hungerford, 7/14/21, 7 ♂♂, 9 ♀♀.

CAROLINIAN FAUNA

KANSAS. *Atchison Co.*, R. H. Beamer, 7/11/24, 6 ♂♂, 16 ♀♀, 7/25/24, 1 ♀; E. P. Breakey, 7/15/24, 2 ♂♂, 11 ♀♀. *Douglas Co.*, Robert Guntert, 10/28/21, 1 ♀; William E. Hoffmann, 1/23/21, 1 ♀, 5/10/19, 1 ♀; H. B. Hungerford, 2/23/21, 1 ♀, Stubbs Pond, 4/8/21, 7 ♀♀, Rock pool, 5/31/16, 2 ♀♀; P. B. Lawson, Trap Light, 6/21/28, 1 ♂, 1 ♀, 7/22/30, 1 ♂; 900 ft., 7/09, 4 ♂♂, 8 ♀♀. *Lawrence*, L. S. Henderson, Trap Light, 7/35, 2 ♂♂, 7 ♀♀. *Topeka*, H. B. Hungerford, 5/26/23, 4 ♀♀; R. H. Beamer, 5/26/23, 1 ♂. *Osage Co.*, C. O. Bare, 6/23, 2 ♂♂, 6 ♀♀; R. H. Beamer, 6/23, 1 ♂, 3 ♀♀, 6/15/23, 3 ♀♀. *Lyon Co.*, C. O. Bare, 6/23, 3 ♂♂, 2 ♀♀. *Bourbon Co.*, R. H. Beamer, 800 ft., 1915, 1 ♀. *Allen Co.*, Wm. E. Hoffmann, 4/24/21, 1 ♂. *Woodson Co.*, Wm. E. Hoffmann, 2/24/21, 7 ♀♀. *Montgomery Co.*, R. H. Beamer, 798 ft., 1916, 3 ♀♀. *Republic Co.*, R. H. Beamer, 7/11/35, 1 ♀. *Saline Co.*, L. C. Woodruff, 7/14/23, 2 ♂♂, 6 ♀♀; R. H. Beamer, 7/18/23, 1 ♂, 9 ♀♀. *Medora*, L. D. Anderson, 7/3/27, 1 ♂, 1 ♀; R. H. Beamer, 7/2/27, 1 ♂, 1 ♀; P. A. Readio, 7/2/27, 4 ♂♂, 6 ♀♀. *Barber Co.*, R. H. Beamer, 1468 ft., 1916, 3 ♀♀.

UPPER SONORAN FAUNA

KANSAS. *Decatur Co.*, F. X. Williams, 2560 ft., 1 ♂. *Logan Co.*, F. X. Williams, 3322 ft., 1 ♀. *Wallace Co.*, F. X. Williams, 3440 ft., 1 ♂. *Morton Co.*, C. O. Bare, 8/2/24, 1 ♀; 7/20/24, 2 ♂♂, 3 ♀♀.

COLORADO. *Hadley*, P. A. Readio, 9/22/27, 1 ♀.

TEXAS. *Randall Co.*, R. H. Beamer, 7/7/27, 1 ♀.

AUSTRORIPARIAN FAUNA

ILLINOIS. *Olive Branch*, Owen Bryant, 9/5/23, 2 ♂♂, 2 ♀♀.

ALABAMA. *Crawford*, Paul W. Oman, 7/24/30, 1 ♀.

MISSISSIPPI. *Lauderdale*, R. H. Beamer, 7/17/30, 2 ♂♂, 14 ♀♀. *Ocean Springs*, C. J. Drake, 7/29/21, 1 ♀. *Vicksburg*, C. J. Drake, 7/19/21, 3 ♂♂, 3 ♀♀. *Woodville*, 7/26/21, 3 ♂♂, 5 ♀♀. *Scooba*, R. H. Beamer, 7/17/30, 1 ♀.

OKLAHOMA. *Tulsa Co.*, Grace Wiley, 3/16/22, 1 ♂, 1 ♀. *Ardmore*, H. B. Hungerford, 4/14/23, 3 ♂♂, 25 ♀♀.

TEXAS. *Dallas Co.*, D. D. Millspaugh, 3/2/39, 2 ♂♂, 1 ♀. *Athens*, Millspaugh, 12/5/38, 1 ♂, 2 ♀♀. *Colorado Co.*, Grace Wiley, 4/22, 32 ♂♂, 97 ♀♀, 1 5th instar, 5/22, 71 ♂♂, 128 ♀♀, 11/11/22, 1 ♂. *Harris Co.*, R. H. Beamer, 8/12/28, 1 ♀. *Beasley*, L. D. Tuthill, 11/7/32, 18 ♂♂, 24 ♀♀. *Brazoria Co.*, L. D. Beamer, 8/12/28, 4 ♂♂, 8 ♀♀. *Victoria*, Garcitas Creek, L. D. Tuthill, 11/8/32, 1 ♀. *Sinton*, L. D. Tuthill, 11/8/32, 19 ♂♂, 43 ♀♀.

LOWER SONORAN FAUNA

TEXAS. *Colorado City*, L. A. Stephenson, 7/17/27, 1 ♀. *Eastland Co.*, Grace Wiley, 4/29/21, 2 ♂♂, 8 ♀♀, 5/21, 77 ♂♂, 472 ♀♀, 7 5th instars, 1 4th instar, 6/2/21, 1 ♀. *Jim Wells Co.*, R. H. Beamer, 7/24/28, 3 ♀♀. *Alfred*,

R. H. Beamer, 7/24/28, 6 ♂♂, 5 ♀♀. *Brooks Co.*, R. H. Beamer, 7/25/28, 2 ♂♂, 3 ♀♀; J. G. Shaw, 7/25/28, 2 ♂♂. *Falfurrias*, L. D. Tuthill, 11/2/32, 1 ♀. *Starr Co.*, J. G. Shaw, 7/30/28, 15 ♀♀; R. I. Sailer, 7/5/38, 3 ♂♂, 18 ♀♀. *Cameron Co.*, J. G. Shaw, 8/3/28, 1 ♀. *Hidalgo Co.*, E. I. Beamer, 8/14/28. 1 ♀; J. G. Shaw, 8/3/28, 5 ♂♂, 5 ♀♀; L. D. Tuthill, 11/22/32, 1 ♀. *Del Rio*, H. D. Thomas, 1937, 2 ♂♂, 8 ♀♀.

MEXICO (SONORAN FAUNAS)

SAN LUIS POTOSI. Km. 447 on road to *Loredo*, Nr. Valley San Luis Potosi, No. 42, H. D. Thomas, 9/28/38, 5 ♀♀.

AGUASCALIENTES. Five miles south *Aguascalientes*, Smith & Dunkle, 7/16/34, 1 ♀.

JALISCO. Twenty miles S. *Guadalajara*, H. D. Thomas, 9/10/38, 5 ♂♂, 1 ♀, Tequilla Rd. 28 mi. N., 9/13/38, 1 ♀. *Tecolotlan*, H. D. Thomas, 9/15/38, 1 ♂, 4 ♀♀, 9/17/38, 1 ♀; L. J. Lipovsky, 9/16/38, 5 ♀♀.

MICHOACAN. *Patzcuaro*, H. D. Thomas, 8/31/38, 1 ♀. *Carapa*, H. D. Thomas, 9/2/38, 3 ♀♀. *Morelia*, H. D. Thomas, 9/3/38, 2 ♂♂, 6 ♀♀, 9/4/38, 23 ♂♂, 26 ♀♀. *Zamora*, H. D. Thomas, 9/8/38, 3 ♂♂, 6 ♀♀, 9/9/38, 3 ♀♀. *Zacupu*, L. J. Lipovsky, 9/1/38, 1 ♀. Twenty miles E. of *Zitacuaro*, 9/28/38, H. D. Thomas, 2 ♂♂, 3 ♀♀.

HIDALGO. *Real del Monte*, H. D. Thomas, 9/23/38, 1 ♀, No. 29; L. J. Lipovsky, 9/23/38, 1 ♂, 2 ♀♀.

VERA CRUZ. West of *Jalapa* 15 klm., H. D. Thomas, 7/18/37, 1 ♂, 1 ♀.

PUEBLA. *Tehuacan*, H. D. Thomas, 7/18-25/37, 20 ♂♂, 15 ♀♀. *Cacaloapan*, H. D. Thomas, 7/22/37, 11 ♂♂, 10 ♀♀.

Ramphocorixa rotundocephala Hungerford

TROPICAL FAUNA

AQUIDILLA, PUERTO RICO. Near *Isabela*, Julio Garcia Diaz, 5/12/35, 14 ♂♂, 47 ♀♀ (Plesiotype ♂).

SONORAN FAUNAS

CHIAPAS. *Comitan*, Octavio Utrilla L, 1/18/38, 1800 M, 1 ♂; H. D. Thomas, 8/30/37, 13 ♂♂, 40 ♀♀. *L. Tepancuapan*, H. D. Thomas, 8/28/37, 1 ♂. *Ocozucuantla*, H. D. Thomas, 7 ♂♂, 9 ♀♀.

VERA CRUZ. *Santa Lucrecia*, M. F. (Dampf), 11/9/30, 1800, 1 ♂, 1 ♀.

MICHOACAN. *Carapa*, 9/8/38, 3 ♀♀.

JALISCO. *Tecolotlan*, 9/15/38, 2 ♀♀.

SONORA. *Salitial Rio Mayo*, H. S. Gentry, 2/23/35, 1 ♂, 1 ♀.

ARIZONA. *Baboquivari Mts.*, R. H. Beamer, Jr., 7/16/32, 5 ♂♂, 1 ♀.

These lists do not include the many specimens of *Ramphocorixa acuminata*, in all stages and seasons, which I have taken in eastern Kansas from 1935 to the present date (Table I). Also, through the kindness of Dr. H. B. Hungerford, several older corixid collections were made available. The most of the material found there had been noted in the literature outlined in the historical synopsis; but some records of *R. acuminata* may be added: Prentiss, Ohio, 7/17/16, C. J. Drake, 1 ♂, 1 ♀; Victoria, Texas, at light, 7/16/12, B. R. Coad, 1 ♂; San Jose, Tamps., Mexico, April, 1910, 3 ♀♀. Three

♀ ♀ from Normal, Ill. (P. R. Uhler Coll., U. S. N. M.) were labeled *C. obliterata* Uhler, and the specimens labeled *Corixa scutellata* (noted by Bueno) were found. The types selected by Abbott for *Ramphocorixa balanodis* were examined: a male labeled "St. Louis, Mo., October 1911" and a female labeled "Columbia, Mo., VII, 1909, J. F. Abbott."

TABLE I. *Ramphocorixa acuminata* in Douglas County, Kansas

MONTH.	Egg.	Nymphal instars.		Adult.
January				1/22/38
February				2/26/38
March				3/7/37
April	4/18/38			4/8/36 4/18/38
May	5/10/36 5/23/37 5/31/37	5/19/37 5/20/37 5/23/37 5/31/37	3, 4, 5 3, 4, 5 3, 4, 5 3, 4, 5	5/7/36 5/7/37 5/9/36 5/10/36 5/19/37 5/20/37 5/23/37 5/31/37
June	6/13/36 6/16/36	6/3/37 6/13/36 6/15/36 6/16/36	3, 4, 5 3, 4, 5 3, 4, 5 3, 4, 5	6/3/37 6/13/36 6/15/36 6/16/36 6/18/36 6/19/36 6/21/36 6/22/36
July	7/14/41	7/11/41 7/14/41 7/16/36 7/18/36 7/20/36	4, 5 3, 4, 5 4, 5 5 3, 4, 5	7/11/41 7/14/41 7/16/36 7/18/36 7/20/36 7/25/36
August		8/10/36 8/29/41	3, 4 3, 4, 5	8/2/41 8/10/36 8/29/41
September	9/8/37 9/9/37 9/29/35	9/1/40 9/5/36 9/9/36 9/9/37 9/10/37 9/15/37 9/18/37 9/26/37	3, 4, 5 5 5 3, 4, 5 3, 4, 5 3, 4, 5 3, 4, 5 3, 4, 5	9/1/40 9/5/36 9/9/36 9/9/37 9/10/37 9/15/37 9/18/37 9/26/37
October	10/3/37 10/23/37 10/24/37	10/1/37 10/3/37 10/14/37 10/31/37	3, 4, 5 3, 4, 5 3, 4, 5 3, 4, 5	10/1/37 10/3/37 10/14/37 10/23/37 10/31/37
November	11/1/35	11/7/37 11/26/37	5 5	11/7/37 11/8/35 11/14/37 11/26/37
December	12/30/37			12/30/37

With the accumulated data, the suggestion (Jaczewski, 1931) that *Ramphocorixa* was originally Sonoran, spreading subsequently eastwards toward the Atlantic coast, would seem supported, in part. The greatest differentiation of the genus, as known, is in the Sonoran faunas where it has at least two species, and both are most numerous there. Individuals of *Ramphocorixa acuminata* are rare in the Alleghanian fauna (and probably the Transition), and plentiful in the Carolinian and Austroriparian, particularly in the southern and western portions grading into the Upper and Lower Sonoran faunas, where the corixid is strikingly abundant. In the literature the species has been reported most frequently from the Carolinian and Austroriparian, but the areas occupied by these faunas are notably those most thoroughly collected until recent years.

Pasture ponds and comparable water holes are typical in Sonoran areas, and *Ramphocorixa acuminata,* in turn, is typically a resident of such water bodies. The preference is at least susceptible to explanation by inheritance, and this would entail an exceedingly long history in the plains pond habitats. Ponds and shallow lakes, often amazingly extensive, have been features of the Mexican landscape for an untold number of years. Here are found incredible amounts of corixid bugs, including those long-famous species of *Corisella* which have supplied the natives with food through many centuries. *Corisella* also accompanies *Ramphocorixa* in Kansas pasture ponds.

Prevailing southerlies often sweep across the southwestern plains regions during the drier seasons (May-October) when the ponds are evaporating and the corixids are migrating. Insects do not necessarily fly with the wind (Lutz, 1927), but it is probable that the dispersal of our species has been hastened and assisted by these persistent currents. Felt (1938) describes the importance of convection—"nature's escalator"—in lifting insects high above hot, bare areas, where they may join the through traffic on the wind, until some new factor, individual or meteorological (Wilbur, 1939), induces a landing. The increase in the number of artificial ponds may assist in providing way stations. (See Whitfield, 1939, for an excellent bibliography on insects and wind.)

It is thus possible to picture the origin of *Ramphocorixa acuminata* in the Sonoran Southwest (probably in Mexico) and its distribution northeastward through the Mississippi Valley. This leaves the question of the other species and the origin of the genus. *R. rotundocephala* is evidently well distributed through the Greater Antilles and Mexico, north to Arizona. The prevailing winds, and hurricanes (Tannehill, 1938), sweep across these areas from east

to west, following the chain of islands into the peninsula of Yucatan or crossing the Gulf into the Mississippi Delta region. If these wind currents have served at all in distribution, it was probably in this direction, out of the islands and on to the continent. The appearance of the males of the two species would seem to indicate *R. rotundocephala* more nearly approaches the generalized corixid type, and is probably the older species. The suggestion is that *Ramphocorixa* was originally an island or Neotropical form, which entered the Sonoran areas of Mexico through its tropics, and found there inducement for the specialization and subsequent distribution which have given the Middle West a most interesting water bug.

PART 2—THE LIFE OF THE WATER BOATMAN

"There seems to be little doubt that any organism, man included, is born with a certain equipment in the way of capacity or ability. Environment may give the organism the opportunity to bring this to the greatest possible function. . . . All that science has been able to say about the organism is that it is a 'coördinated, self-perpetuating system of activities.' Its primary quality is continual activity. Like environment it is always changing."—Pearse (1932).

SOME ASPECTS OF THE STUDY

An honest historian must often hurdle the obstacles of prejudice, hearsay, misinformation, and stubborn opinion, before reaching the simple truth. The writer of a *life history* must also draw the fine lines between fact and opinion, normal and abnormal, observation and interpretation—sorting and fitting together the pieces of information from field and laboratory, and keeping himself out of the picture, as much as possible. In this, the living habits of *Ramphocorixa acuminata* may seem attended with peculiar difficulties of collection and study.

The pasture pond is at best a variable, even a most temporary, water body: drought may force the adult corixids into unpredictable flights, leaving the nymphs and eggs to meet abnormal conditions or perish. Nor do the adults wait upon drought, but migrate often for less accountable reasons, thereby disturbing the proportions in the pond population. The question of proportions must in turn disturb the collector, who attempts a fair estimate of the stages and numbers present from the limited catch which can be taken. The nymphs of *Ramphocorixa* in the beginning stages, for example, are extremely small and may be missed altogether.

All stages are protectively colored and active, while the water

of their normal habitat is frequently discolored and darkened by debris kicked up from the bottom or dropped in from above by wading livestock. (Note also the reflection of their surroundings by such glossy submerged animals, in Ward, 1920.) Day to day observations must be made in the laboratory. The fragile bodies are easily weakened or broken, and mortality is usually high in experiments involving transportation from pond to aquarium. Here some agility is needed in studying the restless corixids under proper magnification. Adults may fly from the containers, or suffer fatal injury against a cover. The data on individuals are always subject to sudden interruption by the high mortality among confined representatives of all stages.

Finally must come the assemblage of the results of observations and experiments performed in a variety of conditions with a variety of success, to form a logical whole susceptible to reasonable interpretation. In this final assemblage of facts and probability, there is the problem of distinguishing normal reactions and activities from abnormal findings resulting from the abnormal conditions of confinement, whether in the aquarium or in a drying pond.

With all these difficulties, the study of the life of a water boatman is calculated to inspire the worker with an enthusiasm serving to surmount the most of the obstacles. (Note Abbott, 1912; Hungerford, 1917, etc.) The insect is one to which there is attached no human prejudice, for the conduct of its affairs in no way obstructs or makes unpleasant the course of mankind's doings. It is somewhat beneficial as a desirable fish food. Its patterns and coloration are harmonious, even beautiful, and the whole effect of the insect is one of trimness and efficiency. Indeed, as pointed out by Kirkaldy (1908), the Corixidae seem to have gained more complete mastery over the problems of aquatic existence than any of their relatives, judging by their numbers. The water boatmen have been successful in a number of curious habitats: in brackish water ponds and pools at dry Tortugas (Pearse, 1932a), in salt water (Hutchinson, 1931), and in hot springs (Brues, 1932).

In addition, *Ramphocorixa acuminata*, with which this study deals particularly, lays its eggs upon crayfish—surely, here is an instance worthy of inclusion in the chapter of Dixon and Eddy (1925) on "Strange Associates"! The peculiar habit is of such unique and interesting nature that it has been discussed again and again in entomological literature, as indicated in the preceding section. But the last word has not been written, nor will be in this

treatment. In this changing world of fact and opinion, a monograph may add a chapter, but it will never conclude the history of a species.

THE CORIXID-CRAYFISH ASSOCIATION

THREE THEORIES

In view of the extreme interest attached to the habit of oviposition upon crayfish, it is appropriate that attention should have centered upon that phase of the life history, and that the egg-laying habit was the introduction of *Ramphocorixa acuminata* to entomological literature. It is not surprising to find that certain definite opinions have been formulated by different authors to explain the interesting association. Three theories have been published, and the latest and most ingenious of these is now widely accepted. The theories may be quoted from the literature cited in the preceding section:

(1) *Protection of eggs from drought by the migratory habit of the crayfish* (S. A. Forbes, 1878). "I can account for so strange a habit only by supposing that it is a 'provision of nature' to guard against the waste of eggs otherwise resulting from the drying up of the ponds. The crawfishes mentioned are distinctively aquatic species, and as one pond dries up they migrate to another, or to a neighboring stream, bearing on their hospitable backs, as the shepherd bore Oedipus from impending destruction, the hopes of the distressed water bugs."

(2) *Protection of eggs from enemies by the pugnacious nature of the crayfish, and a theory of symbiosis* (J. F. Abbott, 1912). "The investiture of eggs commingled with debris certainly renders the crayfish less conspicuous and it probably profits by the arrangement in much the same way as do various shore-crabs which are decorated with sponges, algae or coelenterates. Whether the water bug improves its chances against racial extermination by the adoption of such a pugnacious protector it may be too much to assume, but at any rate whatever the utilitarian value of the habit it must be of the same nature as that which obtains in the widely distributed genus, Zaitha."

(3) *Aëration of the eggs, largely through activity of the gills of the crayfish* (H. B. Hungerford, 1919). "When we study the respiration of the crayfish we find that a current of water is kept passing beneath the carapace and over the gills. This water enters the gill chamber from the rear, passing directly by the abdominal pleurites. The current would be strongest at the first abdominal pleurite, and

it is just here that we find the first eggs. . . . The eggs, therefore, are placed upon the crayfish in the region where there are the best chances for aëration. If only crayfish heavily burdened were examined, it would not be so apparent, but . . . if the oviposition be light, it is obvious at once that there is a choice coincident with the region bathed with the freshest water."

Summary. It is evident that the logic of natural selection has been applied in these three theories. Certain benefits are supposedly derived from the attachment of the eggs upon the crayfish; we must then infer that the habit has become fixed through infinite time by the elimination of the individuals which missed these advantages. Through protection from drought, enemies or stagnation, we are led to believe that the eggs of *Ramphocorixa acuminata* survive best upon the crayfish, and the theory of aëration benefits is particularly well supported. However, from additional observations and experiments, there evolves another possible interpretation of the relationship between the crayfish and the water bug (p. 273). The groundwork for this new theory may be found in the following descriptions and notes.

THE EGG

The egg of *Ramphocorixa acuminata* was described by Abbott (1912): "Length, about .9 mm. Breadth, about .4 mm. Shape, elongate-oval, bilaterally rather than axially symmetrical, *i. e.*, one side nearly straight, the opposite strongly curved. Colour grayish yellow (later stages only were observed); the surface ornamented with a delicate tracery in the form of interlocking hexagons like a honeycomb or the facets of a compound eye. The egg is fastened in a sort of shallow cup which is of a leathery texture and dark brown in colour. The distal end through which the nymph emerges is provided with six to eight short lobes arranged in a circle. The appearance of the whole egg is much like that of a minute Grantia sponge." To this description Hungerford (1919) added that "the ovum has a transparent button and tip, while the body of the egg is yellow," and Poisson (1933) mentioned the egg of *Ramphocorixa* briefly as "semi-cylindrique."

The length of the new-laid egg is about .85 mm., including the small buttonlike tip but not the pedestal; the latter increases the length to about .9 mm. The diameter of the new-laid egg is .35 mm.-.4 mm., increasing with the appearance of the eye-spots before eclosion. The color is ordinarily a creamy-yellow, though there is much variation and the egg-shell may be affected by stains or dis-

figured by clusters of microörganisms and debris. A clean shell appears smooth and polished under low-power magnification. High-power and transmitted light show the minute hexagons described by Abbott (Fig. 1.). These are mostly irregular, and there are many pentagons, as well. About 30 of these figures would form a chain around the greatest diameter. The figures are often irregularly placed, however, and form neither perfect bands nor spirals, becoming particularly irregular at the tip. They do not separate when the egg is broken, but tear across irregularly. Under high magnification the egg-shell surface appears pebbled or roughened with many tiny protuberances.

In side view, the small distal nipple is discovered with high magnification to be made up of numerous long processes. These and the distal plates form a tiny rosette when viewed from directly above. The finger-like appendages are respiratory filaments, according to Poisson (1933), and concealed within the rosette are the micropylar canals. This interpretation seems to agree as well for *Ramphocorixa* as for the other genera studied by Poisson, who stated: "La dispostion des appendices pneumatiques, des micropyles, et du disque de fixation reste la même dans tous les oeufs que j'ai pu examiner."

The pedestal of the egg resembles the rubber suction disks used to attach objects to smooth surfaces. The egg is fastened to the disk by a thick, elastic tendon, resting in a small cupped protuberance upon the circular base. The disk is usually a light brown.

Eggs dissected from the female are exactly similar to the new-laid eggs, though the diameter is commonly somewhat less and the color more yellow. The pedestal is here a short, elastic extension ending in a small, thick disk—all quite clear. It is evident that the brown, leathery appearance is given the pedestal when it is attached by a thick coating of a cementing fluid. In *Ramphocorixa* there are commonly 10-12 fully developed eggs in the abdomen at one time, plainly visible through the cuticula, packed tightly against the body wall. Butler (1923) has reported taking 20 eggs from the body of a female *Corixa geoffroyi*, and the bodies of *Arctocorixa* females in this region may contain a dozen or more. While *Ramphocorixa* is smaller than the latter genus, the eggs are fully as long, though of less diameter; however, as many as 22 eggs may be contained, appearing deeply indented by the pressure against one another in the packed abdomen. The dissections were made among specimens collected both in July and in September. Even though the larger number of eggs contained be the rule rather than the exception, it must

be realized that many individuals play a part in thoroughly covering a crayfish (Fig. 2).

The egg-laying of *Ramphocorixa acuminata* has been observed in the balanced aquarium (p. 297). Butler (1923) described the oviposition of *Corixae*, as follows: "In depositing an egg, the ♀ grasps the leaflet or portion of the plant selected, with the first two pairs of legs, and then a longitudinal motion of the abdomen is observed, the tip resting on the spot where the egg will be laid. During this movement, the minute drop of the fluid which affixes the egg to the plant is emitted and placed in the desired position; the egg is then laid with the micropyle farthest away from the point of attachment, and the ♀ swims away. Several days may be occupied by a single ♀ in laying her batch of eggs, the number deposited daily decreasing."

Strength of attachment. Anyone familiar with the habits of crayfish will immediately realize the necessity for a firm attachment of the water bug eggs, if they are to ride safely through constant sliding into burrows, lunges toward prey, and vigorous backward dashes through pond waters laden with silt and debris. Abbott suggested that the eggs rested in shallow pits in the crayfish cuticula, but this must be considered exceptional or accidental, and owing to the normal roughness of the crayfish coat. The pedestals may be pried away with a needle, especially after being soaked in alcohol for some time; on the living crayfish, a vigorous scraping is needed to loosen the egg-bases. The tendon commonly weakens first in nature, the egg then dropping off and leaving the disk upon the crayfish, enclosed in the brown coat of glue. This does not mean that the short tendon is weak; it is highly elastic and amazingly strong. A fairly large crayfish (45 mm.) may be picked up and waved about by simply gripping an egg firmly with forceps and hauling the creature aloft!

The elasticity of the connecting fiber is as amazing as its strength. A *Ramphocorixa* (or *Corisella*) egg may be held with forceps and another pair used to separate the base from the body of the egg, connected only by a clear, elastic fiber. This may be stretched as much as .3 mm. and will spring back into position when released. The roughest treatment does not affect the elasticity of the ligament, as long as its elastic limit is not surpassed. It may be drawn out to that point many times with very little weakening, and a hard tug is needed to pull the base completely away. The procedure may be performed in water or alcohol.

The eggs of *Ramphocorixa acuminata* are often deposited on the appendages of crayfish, where they are constantly moved about and brushed against objects, though receiving little attention from the crayfish, beyond an occasional aimless plucking. The strength of the fibrous pedestal and the attachment of the base are somewhat weakened after hatching, and the eggs may drop off their bases or detach entire. But crayfish have been kept over winter from December to March, losing very few of the hundreds of eggs upon them, though eclosion occurred in early January and the crayfish were rolled about in a forceful current several times each week. It is evident that eggs freshly deposited with a firmly adhesive base and a springy, stout pedestal are definitely "put on to stay."

The egg shell is also tough and flexible. Eggs must be vigorously squashed to be broken, and probably sustain severe bumps without injury. But they quickly fall victim to desiccation when exposed to the air. The quick drying of corixid eggs is amply illustrated by any of the accounts* of *ahuautle* collecting in Mexico, where the natives dry immense quantities of the eggs upon flat, hard ground. In a few hours, eggs taken from pasture ponds and dried are completely beyond recovery. The shell collapses and indents deeply upon one side. When returned to water, the eggs float on the surface and do not hatch.

THE CRAYFISH

The irascible temperament of the crayfish is so eternally displayed that the ovipositing of *Ramphocorixa* seems comparable to the courageous feeding of tiny tick birds in the crocodile's mouth—even more dangerous, for the birds are protected by the indulgence of the reptile, by most accounts. It is hard to conceive just how the eggs are sometimes laid bordering the mouthparts. Coupled with its irascibility, the crayfish possesses an insatiable appetite. It is well-described by Huxley as "a voracious and indescriminate feeder," and in the aquarium will senselessly founder itself, if given too large quantities of food. The crayfish commonly partakes of small fishes and *water insects,* which may lead us to wonder if it might not find *Ramphocorixa* tasty.

On several occasions crayfish have been observed to stalk and devour the adults, feeding chiefly at night. The nymphs are also eaten—even first instars when these are confined with the crayfish in a bowl. On crayfish taken in December, the eggs must have

* Say (in LeConte, 1859), Figuier (1872), Glover (1877), China (1931), Hegner (1936), and others. Also described by H. D. Thomas, Kan. Acad. Science meeting, Pittsburg, 1938, with motion pictures. The eggs, or "water wheat," are used in making flour or marketed as bird food.

produced several hundred nymphs (judging from examination of the shells), but none was ever found on the mornings following eclosion.

We may suppose a strong and vital stimulus provokes the approach of the female *Ramphocorixa* upon the crayfish for oviposition. It will be remembered that the female *Belostoma* accomplishes her egg-laying upon the male despite his struggles, and her persistence is thought motivated by the eggs' need for aëration. This provides the cue for considering the aëration possibilities of the crayfish and their relation to the positions chosen for the eggs.

Branchial currents. The gills of the crayfish lie in chambers above the leg-bases, covered by lateral flaps of the carapace, called "branchiostegites" by Huxley (1880). A current is drawn forward beneath these covers by a curved plate (scaphognathite) working near the anterior opening on each side. This small baler was interestingly described by Huxley, who compared the usual action (three or four vibrations per second) to ordinary breathing, and fast action to panting. His observations were made on the common European crayfish, *Astacus fluviatilis;* similar results have been obtained for the lobster (Calman, 1911).

An appreciable current must pass continually over the primary laterotergites of the abdomen and the lateroposterior parts of the carapace, as the water is drawn across these areas in entering the branchial chambers. Simple experiments will demonstrate this current. A small crayfish may be guided into a tilted position in the angle of wall and bottom of a bowl, so that the side of the animal is horizontal. When minute fragments of chalk and bits of paper are placed upon the areas mentioned and upon other parts, in the regions washed by the branchial current the debris is visibly stirred and gradually slips away, while remaining in the other positions. If the powder of dried ink is placed in the water near the posterior opening into the gill chamber, delicate streamers will be drawn through and passed out by the head. Here the current is particularly strong, and the water constantly ripples, especially when the animal is alarmed. When taken out of water, the crayfish bubbles conspicuously at the anterior openings.

PREFERENCES IN OVIPOSITION

In the literature of *Ramphocorixa,* eggs have been described on *Cambarus immunis* Hagen, *C. blandingii acutus* Girard, and the subgenus *Cambarellus* Ortmann—usually on the first species. Papers on crayfish were explored for additional records, without success. Among these were the works of J. A. Harris, whose collec-

tion was made available by C. D. Bunker and given a thorough going-over (Table II). In the fourteen species and four varieties of *Cambarus* studied, only three determined species (*C. immunis, simulans,* and *virilis*) bore eggs of *Ramphocorixa acuminata.* These are crayfish of ponds and water holes, though the latter two are found as commonly in streams. Half the crayfish bearing eggs were

TABLE II. Corixid Eggs on Crayfish in the Harris Collection

SPECIES OF CRAYFISH.	No. exam.	Size* (mm.)	With eggs.	Size* (mm.)	♂♂	♀♀
Cambarus sp.	331	27–92	47	44–91	9	38
C. virilis	120	23–102	1	90	1	.....
C. gracilis	81	31–85	.....	.....	.....	.....
C. immunis	58	35–100	40	50–100	19	21
C. neglectus	26	35–75	.....	.....	.....	.....
C. simulans	20	40–89	6	67–85	4	2
C. diogenes	16	41–114	.....	.....	.....	.....
C. nais	15	33–74	.....	.....	.....	.....
C. obscurus	14	40–75	.....	.....	.....	.....
C. bartonii	11	44–70	.....	.....	.....	.....
C. immunis spinirostris	7	40–60	.....	.....	.....	.....
C. pilosus	6	80–85	.....	.....	.....	.....
C. affinis limosus	5	68–77	.....	.....	.....	.....
C. bartonii robustus	4	57–76	.....	.....	.....	.....
C. blandingii acutus	4	55–85	.....	.....	.....	.....
C. monongalensis	4	47–67	.....	.....	.....	.....
C. rusticus	3	40–60	.....	.....	.....	.....
C. carolinus	3	48–65	.....	.....	.....	.....
Totals	728	.....	94	.....	33	61

* Size = length, tip of rostrum to extremity of telson, of the smallest and the largest specimen in each series.

undetermined but mostly recognizable as *C. immunis;* of the named specimens, forty out of forty-seven belonged to this species, which is most widely distributed and common in ponds. A large proportion of *C. immunis* carried the eggs of *Ramphocorixa:* forty specimens of the fifty-eight examined. Probably the importance of this crayfish to the corixids is primarily due to its presence typically in the pasture ponds of areas inhabited by the bugs. But other factors must be involved, such as periods of exuviation and time of appearance in the ponds. For example, *C. gracilis* is a pond-dwelling species, but retires frequently to burrows, and Harris (1902) noted that it is

rarely found as an adult in open water during the summer. Several crayfish from eastern Arkansas carried the eggs of our corixid, adding another state to the distributional list. The Harris collection also added two new records of crayfish species used as egg-bearers: *C. virilis* in Missouri (a single and probably exceptional instance) and *C. simulans* in Kansas.

In the Limnology collection (Kan. Univ. Entomology Dept.) two of the fourteen crayfish examined carried *Ramphocorixa* eggs. These were *Cambarus blandingii acutus* from Oklahoma, the only species other than *C. immunis* from which the corixid eggs have been previously reported. Creaser and Ortenburger (1933) described the ecology of the species: "This crayfish frequents stagnant water. Bogs, slowly moving streams and rivers and ponds are its favorite habitat. Sometimes this crayfish builds a shallow burrow when the water-level falls in the ponds during dry seasons." Lonnberg (1898, in Harris, 1903) noted that "The late Capt. C. Eckman, at Savannah, Ga., collected Cambarus (blandingii) in the hollow trunk of a fallen tree, two English miles from any open water." The specimens bearing the eggs are recorded from North Canadian River, but this may not indicate the presence of *Ramphocorixa* in the stream, since the crustaceans may have been collected in neighboring ponds or have migrated from them to the river.

In Table II, the crayfish bearing corixid eggs are fairly large, the average about 75 mm. in length. But this must not be taken to show a preference for larger specimens. Collections from Eastern Kansas pasture ponds through the last few years would place the average length between 25 mm. and 50 mm. Twelve representative specimens have been chosen from the collections (Table III).* Eight of these (Nos. 1-8), from two ponds, are *Cambarus simulans,* and the remaining four, from another pond, are *C. immunis.* Since collections were made for the most part with a dip net, not a seine, the proportions of these species are less truly representative. However, *C. simulans* must predominate in certain ponds, rather than the widely distributed *C. immunis.* The ecology of the former species was described by Creaser and Ortenburger: "This crayfish lives in

* Areas on the crayfish in Table III are designated according to the following key: Ro, rostrum; AC, anterior carapace (before cephalic groove); PC, posterior carapace (behind cephalic groove); A 1-6 abdominal segments 1-6; Te, telson; OU, outer uropod; IU, inner uropod. *Positions of corixid eggs within these areas* are indicated by: L, left; D, dorsal; R, right; a, anterior; p, posterior; l, low; h, high; i, inner portion (of uropod); o, outer portion (of uropod). Thus, AC-Ll = anterior carapace, left, low; PC-Lal = posterior carapace, left, anterior, low; A 1-L = 1st abdominal segment, left; Te-a = telson, anterior; OU-Li = outer uropod, left, inner portion.

The eggs sometimes found upon the appendages have not been tabulated (excepting the uropods). Eggs are laid on the chelifers, periopods, the bases of the antennae and eyes, and even upon the maxillipeds—but only occasionally. The anterior appendages more commonly bear eggs than the posterior.

TABLE III. Eggs of *Ramphocorixa acuminata* on Cambarus

No.	1	2	3	4	5	6	7	8	9	10	11	12
Lengths*	53	48	59	46	31	27	42	39	22	22	23	21
Sex	f	m	m	f	m	m	m	m	m	f	m	f
Ro*	24	....	1	....	12	2	8	25	10	6	.....	4
AC-Ll	44	....	....	....	3	.....	.....	30	.....	.....	.....	1
AC-Lh	30	....	....	....	3	.....	.....	36	13	2	.....	.....
AC-D	....	....	....	....	3	.....	.....	30	17	10	.....	1
AC-Rh	4	....	1	....	26	.....	.....	24	9	17	.....	.....
AC-Rl	....	....	....	....	12	.....	.....	32	.....	.....	.....	.....
PC-Lal	42	....	....	....	.....	.....	.....	32	.....	9	.....	.....
PC-Lah	....	....	....	....	.....	.....	.....	25	12	7	.....	.....
PC-Da	....	....	....	....	.....	.....	.....	27	10	4	.....	.....
PC-Rah	....	....	....	....	7	.....	.....	26	5	7	.....	.....
PC-Ral	....	....	....	....	.....	.....	.....	30	.....	7	.....	.....
PC-Lpl	....	....	....	....	.....	.....	.....	10	.....	7	.....	.....
PC-Lph	....	....	3	....	.....	.....	.....	3	13	6	.....	.....
PC-Dp	....	....	....	....	.....	.....	.....	3	10	6	.....	.....
PC-Rph	....	....	....	....	.....	.....	.....	15	3	1	.....	1
PC-Rpl	....	....	....	....	.....	.....	.....	32	.....	12	.....	.....
A1-L	....	....	....	....	.....	1	.....	2	.....	3	.....	.....
A1-D	....	....	....	....	.....	.....	.....	.....	.....	.....	.....	.....
A1-R	....	....	....	....	.....	.....	2	.....	1	.....	.....	.....
A2-L	16	11	10	....	1	7	.....	9	7	7	.....	.....
A2-D	....	....	....	....	.....	1	.....	.....	4	5	.....	.....
A2-R	17	12	....	2	.....	2	10	7	7	8	2	1
A3-L	6	....	....	....	.....	2	.....	.....	8	8	1	.....
A3-D	....	....	....	....	.....	.....	.....	.....	5	3	.....	.....
A3-R	7	5	....	....	.....	3	10	.....	7	9	1	.....
A4-L	4	....	....	....	.....	5	.....	.....	4	6	3	.....
A4-D	....	....	....	....	.....	.....	.....	.....	2	2	.....	.....
A4-R	....	....	....	....	.....	.....	4	.....	4	7	.....	.....
A5-L	....	....	....	1	.....	4	.....	.....	6	7	5	.....
A5-D	....	....	....	....	.....	.....	.....	.....	.....	3	2	.....
A5-R	....	....	....	....	.....	.....	1	.....	6	6	1	.....
A6-L	....	....	....	....	.....	1	.....	.....	2	5	4	.....
A6-D	....	....	....	....	.....	.....	.....	.....	.....	2	2	2
A6-R	....	....	....	....	.....	.....	.....	.....	1	3	1	1
Te-a	....	....	2	....	.....	.....	.....	.....	6	10	5	1
Te-p	....	....	....	....	.....	.....	.....	.....	2	6	4	2
OU-Li	....	....	6	....	.....	.....	.....	.....	1	7	5	.....
OU-Lo	....	....	....	....	.....	.....	.....	.....	2	5	5	.....
OU-Ri	....	....	....	3	.....	.....	.....	.....	2	10	3	3
OU-Ro	....	....	....	....	.....	.....	.....	.....	3	7	.....	5
IU-Li	....	....	4	....	.....	.....	.....	3	.....	5	3	1
IU-Lo	....	....	....	....	.....	.....	.....	.....	.....	4	4	.....
IU-Ri	....	....	....	....	.....	.....	.....	.....	2	6	3	.....
IU-Ro	....	....	....	....	.....	.....	.....	.....	1	4	1	.....
Totals	194	28	27	6	67	28	35	401	185	249	55	23

* Length in mm.—tip of rostrum to extremity of telson. Abbreviations in footnote, p. 270.

much the same ecological situations as *C. blandingii acutus*. It seems particularly fond of muddy streams and ponds. When these ponds dry during midsummer the crayfish resort to burrows. This species is not essentially a burrowing species, however."

In long series of all sizes, the crayfish show certain areas bearing eggs with fair consistency, though often with a small proportion of the total eggs present. (cf. Hungerford, 1919.) The preference thus indicated is as follows:

(1) The laterotergal plates of the second abdominal segment.

(2) The carapace posterior to the cervical groove, along the lower margin on either side, and particularly in the lower posterior areas.

(3) The carapace anterior to the cervical groove, usually lateral

and upon the rostum. The anterior portion of the carapace may often be covered completely by a mat of eggs.

LIMITATIONS OF THEORIES

Forbes (1878) suggested that the corixid eggs are rescued from drying ponds by the migrating crayfish. If this relationship exists, it is decidedly imperfect. The eggs have been found on four crayfish species; of these, the most migratory has been chosen least. The water bugs make no distinction as to size, though small crayfish might not be equal to sustained trips overland. Nor would the eggs, in all probability, endure a long trek; they are quick drying and do not remain viable afterward. Preference does not guarantee a suitable destination—willful or unfortunate excursions would menace, more than help, the survival of our corixid. The crayfish may not choose to migrate, preferring to sink a shaft, erect a chimney and wait for the rains. These cheerless excavations are often poorly supplied with water in which the crustaceans remain but a part of the time. Nymphs hatched or carried in would meet insurmountable problems in avoiding the lumbering crayfish and digging out a living.

Abbott (1912a) explained the "symbiosis" of the corixid and *Cambarus* as *protective*—the crayfish being camouflaged by the cover of eggs and, in turn, defending them. In comparing the habits of *Ramphocorixa* and *Belostoma*, he also suggested aëration. The pugnacity of the crayfish is unquestionable, but there are some misgivings as to the protection it affords. In the collections from pasture ponds, there are commonly specimens with one leg or more missing, lost in some passage at arms. One, heavily laden with corixid eggs, had only three posterior legs remaining attached, obviously powerless to protect the eggs, or itself. In a well-lighted aquarium where some concealing investiture was surely desirable, the attitude of the crayfish toward the ovipositing water bugs was discouragingly predatory. Both nymphs and adults of *Ramphocorixa* are acceptable to the crayfish palate, although there is no instance of removal or devouring of the eggs. The dangers which the females encounter in oviposition might be concluded to balance fairly the advantages derived by the eggs from the "pugnacious protector." However, the water bug may deposit its eggs at any time, and may have opportunity to approach the crustacean during a somnolent interval. The enemies from which the eggs are to receive protection may be represented by the abundant notonectids, which have been observed to prey upon the eggs of *Belostoma* (Severin, 1910), for

example. But to such swift predators, the crayfish must be a questionable deterrent; indeed, *Cambarus,* successfully approached by *Ramphocorixa,* might be approached by *Buenoa* or *Notonecta,* and others, in turn, and the crayfish would then serve in the capacity of an ambulatory lunch counter.

Hungerford (1919) demonstrated a choice in oviposition coincident with areas washed by gill currents, and proposed that aëration benefits account for the habit. The logic is particularly attractive, since *Ramphocorixa* and *Cambarus* frequent ponds with characteristic stagnation and filth. The respiratory filaments (p. 265) suggest the importance of aëration, and the positions chosen fit this interpretation. However, it does not explain all the facts related to oviposition. China (1931) introduced his discussion by describing several adaptations of water bugs for aërating their eggs; but the habit of *Ramphocorixa* is not quite in the same category. In the other cases (aside from actual structural developments, as in *Nepa* and *Ranatra*), there are *invariable* relationships: *Belostoma* and relatives, for example, always oviposit on the backs of the males. The adaptation for aëration—and possibly protection—is immutably fixed in the behavior pattern. But *Ramphocorixa* may or may not oviposit in the favored positions on the crayfish, and may oviposit without recourse to that animal. Perhaps the "instinct" of the water bug is imperfect; a majority of successes is all that the theory requires. However, many instances suggest another factor which may influence the relationship.

THE FACTOR OF CONVENIENCE

The water bug obviously deposits eggs upon the crayfish when this animal is available—perhaps *because* it is available. This suggestion of availability, or convenience, as a factor in the relationship grows from the following observations:

(1) *Conditions of the pasture ponds.* These are usually shallow, with a bottom of trampled ooze, stirred and pulverized by wading or wallowing livestock. Vegetation, loose sticks and stones are rare, and mostly covered with silt and debris.

(2) *Association of Cambarus and Ramphocorixa.* Both notably prefer the water hole type of habitat, and are found together in the shallows—the corixids pasturing on the algae and other microorganisms, and the crayfish preying on the insects, and one another.*

(3) *Crayfish as convenient egg supports.* Oviposition in Corixi-

* Association as a factor in the choice of the oviposition site is rather curiously shown by Bare's report (1926) of *Notonecta undulata* laying upon *Ranatra* (a "stick-like" insect)! The eggs were successfully hatched, though the *Ranatra* succumbed.

dae requires a firm, fairly smooth surface upon which the egg pedestal may be glued. Such surfaces are not plentiful in turbid water holes—excluding the crayfish. Their bodies are firm and smooth enough; they are frequently in motion and extricate themselves from mud and debris. Their convenience is recognizably conditioned by jaws and nippers.

(4) *Notes and experiments.* Eggs of *Ramphocorixa* have been reported on molluscs (Forbes), tin cans, boards, living snails, sticks, and floating plants (Hungerford). In the past several years, they have been found on water plants, sticks, a tin lid, the whorl of a snail shell, the carapace of a painted turtle. "Egg-traps" of small bottles on cords, weighted to bob freely just off the bottom, found favor with species of *Arctocorixa, Corisella* and *Ramphocorixa.* Our corixid preferred the pieces of sandstone used for weights, the others the cords and bottles. A large screen cage, found exposed in a typical pond by the lower September water level, bore masses of eggs on the screen and tin top. Those exposed to the air were collapsed and brittle, but the others were fresh and in good condition. The screen of one side (about 40 x 20 cm.) was taken to the laboratory in a pail of pond water. The eggs were massed, one on the other, in columns, dendritic arrangements and thick grapelike clusters. Approximately 730 were counted on one representative square centimeter, with deposition on both sides of the screen. About half of these were eggs of *Ramphocorixa,* and the rest of *Corisella.* Nymphs hatched from both in aquaria, and reached the adult stage (p. 287).

Crayfish are sometimes rare in the shallows of ponds where eggs of *Ramphocorixa* have been found on other objects. *Overcrowding* may also explain the choice of alternative oviposition sites, where crayfish are plentiful, and has been suggested (Hungerford, China) to explain extra heavy egg coverings on individual crayfish. Two aquarium experiments are of interest in this connection. In June, several gravid water bugs were confined with a medium-sized crayfish. Numerous eggs were deposited upon leaves of *Vallisneria* and the aquarium wall, one or two inches from the bottom, but none on the crayfish, touring in and out of an improvised den. In September, a crayfish was fastened† in an aquarium where the water bugs were ovipositing upon *Vallisneria.* These plants and the aquarium walls received additional eggs, but not the crayfish, and corixids feeding near showed no interest. Sometime before, in the same

† A copper wire was passed about the cephalothorax and the ends extended through a glass tube. This was attached at the edge of the aquarium and the crayfish suspended just off the bottom.

aquarium, a determined female *Belostoma* cornered her mate and coated him with eggs.

Present convenience alone will not explain the relationship of *Ramphocorixa* and *Cambarus*. Other corixids have equal chance to oviposit upon crayfish, and sometimes do; eggs of *Arctocorixa, Corisella* and *Trichocorixa* species have been found, but these deposits number in dozens, not in hundreds and thousands. At present in pasture ponds, these genera show preference for plant stems and fragments, and *Ramphocorixa* for the crayfish. In the long association of the latter two animals in water holes, the availability of the crayfish might be concluded to have ingrained the preference in the water bug (Wardle, 1929: 87); but more difficult to explain is the choice of certain areas for oviposition. Aëration benefits must surely be received in the currents at the entrance and exit of the gill chamber, but the choice of these positions is, as yet, curiously facultative, and far removed from the obligatory habits of other water bugs concerned with aëration. Perhaps the preference is condition by the effect of branchial currents, and the action of legs and tail, in clearing these areas of debris. Availability easily accounts for the numerous eggs found upon the fore portions of the body (eyes, antennal bases, chelae, maxillipeds), since these regions normally protrude from shelters when the crayfish are at rest.

Summary. The eggs of *Ramphocorixa acuminata* are preferably deposited upon crayfish, usually *Cambarus immunis* and *C. simulans*. These species are typically associated with the corixid in water holes. The oviposition habit is not obligatory, amounting to a fixation of choice in the behavior pattern of the insect, in which preference extends to areas affected by branchial currents. Protection of eggs from drought and enemies are possible benefits accruing from the association; aëration by branchial currents may be a factor in the choice of special areas; while the convenience of the crayfish in long association with the ovipositing water bugs serves largely to explain the relationship.

THE LIFE CYCLE IN PONDS

The adults of *Ramphocorixa acuminata* may mate and lay eggs in the aquarium; these eggs may successfully incubate; nymphs may hatch, feed, molt and grow to maturity. Here studies are concerned with individuals and aquarium conditions. The *life of the species* must be studied in the natural environment, subject to normal physical and biological influences. These vary greatly, according

to the seasons, pond conditions, and the coincidence of organisms. Life histories are often presented in charts, neatly apportioning the year among the various stages, with nothing left out or left over. In the life history of our corixid, chapters frequently overlap, with eggs, nymphs and adults side by side through favorable periods until winter disposes of the less hardy stages. The proportions of instars in long series of collections must solve the problem. Generations overlap, but the greater number will be found in a particular stage in a given season, with the special goal of development, growth, maturation or reproduction.

Opportunity to study the life cycle in the open invites the collector in this region of Kansas. Ponds are numerous in Douglas county (p. 244). Those in easy distance from the road (near the University and the historic Hole-in-the-Rock) were regularly examined. The ponds supporting *Ramphocorixa acuminata* are alike in these respects: They are artificial pools, fed by pasture drainage and intermittent streams, rather than by springs and seepages; frequented by livestock; and bottomed with ooze, rich in microscopic life. The associated species form the typical community described in Part 1 (p. 245).

In shallow pasture ponds, the two great ordeals during the year are drought in summer and solid freezing in winter. *Ramphocorixa* is well adapted to evade or withstand these difficulties. The least enduring stages of growth usually appear in the favorable seasons of spring and autumn, while the adults are most prevalent during summer and winter. There are exceptions because of overlapping generations, but, for the most part, *Ramphocorixa* offers an excellent example of the fitting of a life history within a special environment.

Spring, when the mask of ice lifts at last, is the most interesting season of all. How has the species fared through the winter? What stages of the life cycle will be found? Such questions invite the collector to the ponds. "First appearances" there are often related with difficulty to hibernation. Adults may be collected in small numbers throughout the winter and in early spring. They reach a peak in abundance during May and June, in some ponds bringing *Ramphocorixa acuminata* into a position of numerical dominance. But the increase of adults must be preceded by growth stages in comparable numbers. The earliest record of nymphs in the collections (Table I) is May 19, when third, fourth and fifth instars were taken, indicating that eclosion, for the fifth instars, at least, occurred sometime in April. The earliest record of eggs is April 18, perhaps overwintered

deposits (p. 279); the next, May 10, both hatched and recently deposited. The third stadium of *Ramphocorixa* may be reached fairly quickly after hatching—a fortunate condition, for the minute earlier stages are not obtainable in ordinary collecting. Oviposition accompanies the ascendancy of the adults in the ponds, and eggs are common on crayfish in May and June.

Summer. As a rule, the eggs hatch rapidly (p. 288). Within a week, nymphs may appear and busy themselves in the quick march to adulthood, their progress correlated with the approach of drought. In ponds doomed to extinction in late July and August, the sun must exercise increasing influence upon the organisms of the oozes supplying the corixids with food, and the warmth of the water undoubtedly speeds up development. There may be an unfavorable increase of predators to contend with, but the nymphs have sure agility in escaping these marauders, which are usually after larger game. Thus our species, in part, at least, obtains wings in ample time to salvage its existence by flight. Often in the hot sunshine, which has reduced a pond much below its spring level, corixids have been observed rising from the surface in short, whirling excursions. An extension of these "test flights" would bring about such corixid showers as those reported by Lange (1905), Richardson (1907) and McAtee (1922). Day (1927) described migrations from drying Cumberland ponds.* Migratory flights of *Ramphocorixa acuminata* are frequently indicated by the appearance of the species in isolated ponds and the pools of drying stream beds, in correlation with disappearance of the winged forms in neighboring ponds overtaken by drought; and by re-appearance of the adults in ponds refilled by fall rains. Complete drought is not the rule, but rather the frequent mischance in summer. When it occurs, even the adults lie thick on the mud—food for the killdeer. In those ponds which may suffer a reduction in volume, but otherwise hold their own through the dry season, the larger nymphal instars and the adults are abundant through the late summer, as the species nears its second main period of oviposition.

Fall. In this season, mating and oviposition are as extensive as in the spring. On September 9, numerous specimens of *Cambarus simulans* were found in a small pond, each with a supply of *Ramphocorixa* eggs. Oviposition in this pond evidently continued through the fall, almost to the winter period. On the same date, thousands

* Poisson (1921) described the flight of corixids from overheated laboratory containers; but the same author (1924) gives an account of flight at 15°. The detailed observations of Richardson are particularly interesting.

of eggs were discovered attached to a screened box (p. 274). Crayfish bearing eggs are common in September and October.

Mating was observed in a large pond (September 9),† when exclusion of livestock from the pasture allowed the water to become fairly clear. In the eastern shallows, opposite the high earth dam, many *Ramphocorixa* and *Corisella* were discovered in the bright sunlight. The depth of the water was six inches to one foot, the temperature about 78° F. The observations were made from 2:00 to 3:30 p. m. When side by side with the females (and heading the same direction), the males mounted with a quick, hopping movement. Often this coupling was only for an instant, though females were observed carrying mates for longer periods. Males were seen in pursuit, with heads almost touching the female abdominal apex, following thus for several feet until a pause on the part of the female gave opportunity to mount. One male mounted two females in rapid succession, staying with each but an instant. Another pursued a female for a distance, lost her in the hollows, and mounted another, feeding nearby, for a brief moment. The male then resumed feeding, and the female never ceased its bobbing activity. The females seemed remarkably passive when mounted; the usual indication of recognition of the male's presence was simply a particularly emphatic bobbing movement in the feeding. In some cases, however, there were definite efforts toward evasion. A female swimming by seemed often a challenge to a feeding male, which then took up the pursuit. Indeed, one hapless male was observed patiently following behind a mammoth female *Corisella*, but had no success in mounting. (Larsen, 1938, noted attempts by males to mate with other males.) Throughout the observations, the corixids were busy with the rich ooze, feeding rapidly and continuously. They came rarely to the surface. In half an hour of watching, one male was observed to rise to the top. The corixids seemed quite sensitive to jars; stamping on the mud, a foot from the water edge, caused swift, darting changes of position among perhaps a third of the feeding water bugs.

† Larsen (1938), in a thorough discussion of reproductive structures and habits of water bugs, has given the following information for European species of Corixidae: The water boatmen regularly have short copulation periods, *Corixa dentipes, C. geoffroyi, Sigara sahlbergi,* and *S. linnei* in late March and early May. *Sigara striata* and *Callicorixa praeusta* have a short copulation period in spring and another in summer, with two generations a year. In *Cymatia,* the period begins in middle May, lasting into June. *Micronecta minutissima* overwinter as nymphs, becoming adults in June, with mating in late June and early July. The females of *Corixa dentipes* and *C. geoffroyi* have one long reproductive period, lasting through till spring. Hagemann (1910) showed one generation for *C. geoffroyi,* overwintering as adults and dying in early summer shortly after copulation. The males were said to remain attached 1-2 days. Larsen described the actual copulation as less than one hour, though Butler (1923) gave several hours duration for Corixidae. See, also, p. 296 for aquarium studies.

The adults and larger nymphal instars show no marked decrease, as a rule, until cold weather definitely arrives, usually in November. The nymphs drop first from the collections, and then the adults are greatly reduced, though some continue through the winter season.

Winter. Ordinarily, *Ramphocorixa acuminata* is less available in this season than the associated species of *Arctocorixa* and *Corisella*, particularly the former. However, adults may be found through the winter, even swimming beneath the ice. On February 26, a large pond was invaded through a thick ice coat, and the corixids were fished out, accompanied by numerous water beetles (chiefly *Hydroporus* and *Laccophilus*). Specimens were secured from the same pond in temporary thaws, December 30, January 22, and March 7. There is no doubt that the species passes over the winter in the adult form;* but whether or not this is the only normal hibernating stage may be questioned.

On December 30, three specimens of *Cambarus simulans* were drawn from a small pond partially covered by ice. These crayfish bore each a liberal supply of *Ramphocorixa* eggs upon the carapace and the abdominal laterotergites, in the usual positions. Since the eggs did not appear to be hatched, the crayfish were placed in deep glass bowls and supplied with water. The temperature was much higher than that of the pond (4.1° C.) and results were immediate. Within the week, the eggs began hatching, and continued to hatch well into January. The crayfish devoured the larger parts of the nymphs, but there is no doubt concerning the identity of the eggs and the eclosion.

It seems reasonable that the development of the eggs normally would be much retarded by cold in the natural environment. In this case, development might well be prolonged through January and February into March, with eclosion in March or April. It is not improbable that overwintering eggs may help augment the quantities laid by hibernating adults, and contribute to the ascendancy of *Ramphocorixa* in the late spring. The possibility that nymphal instars safely pass the winter might be suggested. (Hungerford, 1919, recorded third instar nymphs of *Palmocorixa buenoi* wintering at Ithaca, New York.) If so, the instances must be rare, for even sifting floor mud of the ponds has failed to disclose nymphs later

* Adult corixids have been reported under ice by Westwood (1840), the specimens inactive and clinging to one another; by Kirkaldy (1898) in masses; by Bueno (1903), *Corixa harrisii;* and by Wesenberg, (in Brehm, 1930), who recorded great numbers of the adult water bugs, but never the nymphal forms. Howard (1905) gave the adult as the hibernation stage, and noted that specimens captured in the spring are frequently coated with mud; Kellogg (1905) also stated that the adults hibernate in the mud. See Larsen (1938) in footnote, p. 278.

than November. The first two instars might escape attention, but their fragility and normally quick development seem inconsistent with winter survival.

Summary. *Ramphocorixa acuminata* has two marked periods of oviposition in late spring and early fall, indicating a two-generation cycle. The spring peak in egg laying is preceded by growth stages which may result from eggs deposited in late fall or early spring. The occurrence of both eggs and adults through the winter may suggest the interpolation of a third generation. (Hungerford, 1917a, suggested several generations a year for a species of *Arctocorixa*.) More probably, confusion has arisen from overlapping generations. There are two significant peaks in oviposition during the year, but more than a month is involved in each case. Those eggs laid in the first part of the period produce nymphs which may be well toward the terminal stadia by the time the eggs deposited later are hatching. Eggs laid in late summer and early fall produce the hibernating imagoes; other eggs deposited in late fall may have time only to produce nymphs, which are probably destroyed by the cold; still others may not hatch until spring.

ECLOSION

There is no more fascinating maneuver in the life of *Ramphocorixa* than the emergence of the nymph from the egg. Eclosion apparently takes place at all times of the day, but favorite hours seem late at night and early in the morning. In the early hours of September 11, the following observations were made of eggs hatching on the telson of a small crayfish.

2:30 a. m. The tip of an egg has just opened, with four irregular flaps peeling back. The round top of the head bulges slowly upward, covered with a thin membrane. In the center of this covering, between the eyes, is an exact circle of tiny dark patches with a comparatively thick fragment at the top of the circle toward the dorsum (that is, toward the incurved side of the slightly bent egg, Fig. 12). Suddenly the membrane splits and glides rapidly to one side. The nymph is emerging. The legs are tucked against the body, the middle and hind pairs trailing. The body bends and strains. In these movements, the forelegs are thrust foreward together, then down against the body. The nymph expands rapidly, even while emerging, and is out in a moment. Immediately it is much too large for the egg. (cf. Figs. 5, 11.) The movements are feeble, but strengthen noticeably in a quarter of an hour. The nymph is now twice the length and breadth of the shell. It rests at first

against the flaps of the shell, facing the light, and then on the crayfish, beside the egg and facing the other way. Another nymph (hatched 1:00-2:00 a. m.) also rests nearby, after swimming vigorously about when the light was first turned on.

2:50 a. m. The tip of one egg appears as illustrated (Fig. 13). A moment later, the membrane parts and the head emerges, swelling and pulsing, with the eyes immediately widening apart. The front legs appear, parallel and extending caudad. They move away from, and then toward, the body slightly, as movements similar to peristalsis (but swelling, rather than contracting) push the body free (3:10 a. m.). At once the hatched nymph dwarfs the egg. It is quite transparent and the slow movements of its organs are perceptible. Only a moment is needed for emergence, after the parting of the membrane bearing the circle of patches, but the peeling back of the flaps occupies several minutes.

Two additional eggs opened at 2:50 a. m. One of these is illustrated (Fig. 14) at 3:00 a. m. A distinct pulsing, as of the dorsal vessel, showed in the head. The membrane parted at 3:12 a. m., and one full minute was required for emergence. The muscular movements in emerging are remarkable. The body swells anteriorly, and this swelling passes repeatedly toward the egg base with slow bendings, thus forcing out the nymph.

3:23 a. m. The condition of this egg resembles Fig. 14. The membrane parts so that the thick, dark fragment slips to the right. Emergence is at 3:38 a. m., one full minute and twenty-one pulsations of the body being required. The swimming legs slowly unfold and thrust out to the sides, while the front and middle legs remain limp for a minute or two. The middle legs then quickly begin service as clinging organs.

3:46 a. m. The pattern of this egg tip also resembles Fig. 14. Twenty-one pulsations, through one minute, are required for emergence. The movements begin, as in the other cases, instantaneously with the parting of the membrane covering the head.

Our corixid has made its debut as a free agent in the world, and clings near the egg to the handy back of the crayfish. On this frail being, teetering on fragile underpinnings and already beginning to kick vigorously with the swimming legs, there now rests the burden of ceaseless vigilance and eternal trenchering in the long, hard way toward maturity.

THE INSTARS

DESCRIPTIVE NOTES

The minute, transparent first and second instars are rarely taken from ponds, although their high mortality would require them to be numerous. But the larger nymphs may often be found in numbers equaling or excelling the adults. The instars are easily separated with a 12× handlens,* and no more magnification is needed for recognition of *specific* characters. After wing-pads and color pattern appear (third instar), it is practicable to determine the common species of nymphs in the field, once they have been linked with the adults. The problem here amounts to a distinction of genera. Rearing experiments have necessarily established the identities of *Ramphocorixa, Arctocorixa, Trichocorixa* and *Corisella* nymphs, since adulthood with the addition of wings considerably disturbs the nymphal patterns. Three characters, at least, are usable in separating the genera of corixid nymphs: size, color pattern, and appearance of the dorsal glandular patches on the abdomen.

With consideration of size (Table IV), a few notes may be given on form. All nymphs are broadest across the middle, about the third abdominal segment; head and tail are truncations of a boat shape. The body tapers more abruptly caudad, particularly in the fifth instar, where head width increases in proportion to body width and the sides of the thorax build out with enlarged wing pads. The proportions of the body are to some extent generic in significance, *Ramphocorixa* being noticeably the slenderest. Corixid nymphs seem quite flat, due to the compressed abdomen and the opisthognathous head. The lateral portions of the abdomen, especially in the early instars (Figs. 5, 6), are so thin that the medial portion is distended into a prominent lobe containing the vital organs, a condition reminiscent in appearance of the Devonian trilobite *Phacops.*

The sternal regions of corixid nymphs are commonly light-colored —yellow, stramineous, orange or brownish—and do not admit easily recognizable generic distinctions. But the tergal portions are characteristically ornamented with generically separate variations of the general color scheme. The head harmonizes with the ventral color, with a dark mesal point and tuft of hairs on the rim of the vertex. The narrow portion of the prothorax, exposed dorsally when the head is bent down, is covered with fine hairs and has a dark caudal rim.

* *Third Instars* have short wing-pads, the first pair reaching but half the length of the thorax; *fourth instars,* medium pads, the first pair reaching the length of the thorax and almost to the tips of the second; *fifth instars,* long wing-pads, the first pair reaching the tips of the second and exceeding the length of the thorax. (Figs. 7-9.)

TABLE IV. Dimensions of Nymphal Instars collected from Kansas Pasture Ponds*

INSTARS.	Dimensions.	Corisella.	Arctocorixa.	Ramphocorixa.	Trichocorixa.
5th	length	5.883 ± .081	4.950 ± .045	4.596 ± .022	3.837 ± .034
	width	2.430 ± .034	2.097 ± .023	1.815 ± .022	1.608 ± .015
	head width	1.965 ± .030	1.842 ± .018	1.620 ± .013	1.365 ± .012
4th	length	4.128 ± .024	3.564 ± .020	3.474 ± .026	2.730 ± .020
	width	1.893 ± .014	1.641 ± .006	1.479 ± .011	1.230 ± .020
	head width	1.545 ± .009	1.422 ± .010	1.311 ± .009	1.062 ± .007
3d	length	2.967 ± .010	2.505 ± .019	2.610 ± .020	.....
	width	1.530 ± .008	1.254 ± .004	1.194 ± .004	.....
	head width	1.236 ± .007	1.062 ± .005	1.047 ± .002	.....

* Dimensions in mm. from nymphs in 80 percent alcohol. Averages from random samples of ten individuals, the ocular micrometer measuring .3 mm. at 42.5x. Probable error by the Bessel formula.

The dorsal borders of the wing pads are furry with a thick, dark growth of fine hairs, forming an M along the sides and the cephalic margin of the pterothorax. The body in general is less conspicuously hairy (Fig. 9).

A light mesal line extends across the thorax and cervix to the vertex. Along this line, masked in part by the hairiness of the anterior pterothorax, the exuviae divide in molting. Two pairs of light dashes extend on either side of the line into the brown coloration on the mesothoracic tergum. The first abdominal tergite is edged caudally with dark brown; light brown and straw colors continue on the abdomen in a pattern of darker medial and lateral patches set off by lighter areas. In the middle of the third, fourth and fifth abdominal terga, with orifices opening in the posterior margins (bowed forward at this point), are the characteristic dorsal glands.* The first of these seems vestigial, but the second and third are conspicuous bean-shapes and crescents, varying from bright red to darker blood tones. The transparency of the corixid nymphs renders these peculiar bodies of importance in descriptions of abdominal patterns.

With this introduction to general appearances, the generic characters of the larger instars may be summarized in an expanded key. Fifth instars are usually most available, and show the characters best.

* Kunckel d'Herculais (1895) suggested the glands indicate relationship with the Cimicidae. Gulde (1902) claimed the conspicuous dorsal markings were not indications of glands, but merely the sites of certain abdominal muscle insertions! The descriptions of Hagemann (1910) and Brindley (1929; see footnote, p. 317) may be cited particularly. Brief observations were made by Krüger (1909). The glands appear in many terrestrial and aquatic hemipterans, as described by these authors and others. Summaries are given in Weber (1930) and Beier (1938). As indicated by Poisson and Jaczewski (1928), the dorsal glands are relatively less developed in the fifth instar, anticipating replacement by the ventral metathoracic gland in the adult.

1(a) *The lateral posterior margins of the mesothoracic tergum* (where the bases of the wing pads curve mesad) *are distinctly hairy.* The light dashes on the metathoracic tergum are like *Corisella* (2a). The median abdominal color patches are plainly set off by light inverted crescents on the third abdominal tergum and succeeding. The lateral color patches are usually edged by a pair of light lines from the tips of the wing pads to the abdominal apex, joining there to form a conspicuous V next the smoky margins. The dorsal glands are commonly heartshaped, bright red, about 1/7-1/6 of the body width (*e.g.*, 0.31 mm. : 2.0 mm.). In comparison with other genera, the fifth instars are medium-sized (4.9 mm. x 2.1 mm.); the head (1.8 mm.) and body widths are in the ratio of 6 : 7.

ARCTOCORIXA (*viz. alternata*).

1(b) The lateral posterior margins of the mesothoracic tergum are bare. The abdominal patterns are similar, but usually obscured..... 2

2(a) *Two pairs of light dashes on the metathoracic tergum form an anterior bar, touched by a plain posterior* V. The dorsal glands are bean-shaped, a dark blood color, about 1/6 of the body width (*e.g.*, 0.42 mm. : 2.52 mm.). Fifth instars are large (5.9 mm. x 2.4 mm.); the head (2 mm.) and body widths are in the ratio of 5 : 6.....CORISELLA (*viz. edulis*).

2(b) The light dashes on the metathoracic tergum form two V's, the anterior small and sometimes indistinct; the fore-margin of the metathorax is also light 3

3(a) *The dorsal glands are roughly bean-shaped, a dark blood color, and quite large, about 1/4 of the body width* (*e.g.*, 0.42 mm. : 1.58 mm.). *The brown mesal line on the vertex (which is distinctly lobular) continues in an even hairy line on the mesothoracic tergum.* Fifth instars are small (3.8 mm. x 1.6 mm.); the head (1.4 mm) and body widths are in the ratio of 7 : 8 ..... TRICHOCORIXA.

3(b) *The dorsal glands are commonly minute bars or rough crescents, dark and reddish, and quite small, though about 1/7 of the body width* (e.g., 0.26 mm. : 1.79 mm.). *The brown mesal line on the vertex (which is more evenly rounded) does not continue on the mesothorax.* The body proportions are less than 2 : 5 (4.6 mm. x 1.8 mm.); the head (1.6 mm.) and body widths are in the ratio of 8 : 9....RAMPHOCORIXA (*viz. acuminata*).

GROWTH IN AQUARIA

On May 27, a dozen large battery jars (11 × 8¾ × 5¼ in.) were prepared as aquaria. These were lined upon a laboratory table where sunlight reached the first aquarium for about an hour and the others progressively less, the last three receiving no direct sunlight. The water was aërated with compressed air.† Several kinds of bottom materials were used to insure a variety of conditions for the growth of supporting organisms. The preparations were as follows:

A. (Aquarium) 1 & 2. Water (A. 1-6) from Potter Lake (a clear,

† This method was first used at the University by Robert Guntert (Naucorids, 1926); also by C. O. Bare (Buenoa, 1926), and by H. B. Hungerford with other water bugs. See Peterson (1934) for various adaptations.

rock-walled pond on the campus), May 26, pH 7.3. Ooze from a pasture pond, May 27, in a layer of about one inch, passed through a strainer to clear out most of the macroscopic organisms.

A. 3. Fragments of *Typha* from the shallows of Potter Lake, where the water was filled with cattail, *Spirogyra*, plankton scums, sticks, border plants and debris. The fragments had been soaking for several months, and were dark brown, slimy, and easily shredded.

A. 4. Ooze mixed with an equal part of ground *Typha* fragments, passed through a food-cutter which pressed out most of the liquid.

A. 5 & 6. Ground *Typha* fragments (prepared May 26).

A. 7 & 9. Water (A. 7-9) from Potter Lake (May 5, pH 7.6), settled in a large jar, perfectly clear before addition of bottom material. Ooze from a pasture pond.

A. 8. Clean sand.

A. 10. Water (A. 10-12) from a pasture pond (May 6, pH 7.6), settled in a large jar, faintly tinged with yellow-green, containing large numbers of minute Crustacea, mostly Cladocera. Clean sand.

A. 11. Ground cattail fragments.

A. 12. Ooze from a pasture pond.

In each case, the ooze was from a typical pasture pond observed to support numerous *Ramphocorixa;* cattail fragments were established as a successful rearing medium by Hungerford (1919). The mixtures settled well over night, the pH varied little; but the organisms naturally required more time to reach a condition suitable for maintenance. Those commonly found in the aquaria are listed (Table V) from observations made in the fall during rearing experiments with *Ramphocorixa* and *Corisella*. The aquaria containing ground cattail were conspicuously the most successful, particularly A. 6. Bottom samples showed finely divided plant tissue, shining and gelatinous with the multitude of associated organisms. Any of these might be swept into corixid gullets, and some of their remains were obtained from stomach contents (p. 291). Cladocera (*Daphnia*), Copepoda (*Cyclops*), and a few ostracods swam in the constant traffic of planktonts; small snails (*Physa*) and clams toiled on the bottom, where *Tubifex* worms swayed from their numerous tunnels. Nematodes, a leech, and bloodworms were occasionally removed. The larger organisms were characteristic of aquaria containing pond ooze. Immediately following preparation of the containers (May 28-June 13), the later instars of *Ramphocorixa* (in A. 1, 3), *Arctocorixa* (in A. 6, 7) and *Trichocorixa* (in A. 11) were reared to establish identities. The microörganisms fared well over

TABLE V. Aquaria Bottom Materials and Common Organisms

COMMON ORGANISMS.	A. 1, 2, 7, 9, 12: Pond ooze.	A. 4: Equal parts pond ooze and ground Typha.	A. 3: Typha fragments.	A. 5, 6, 11: Ground Typha.
Algae:				
Navicula	*	*		*
Oscillatoria		*		*
Stauroneis	*			
Amphora				*
Scenedesmus				*
Mastigophora:				
Notosolenus	*	*		
Euglena		*		*
Anisonema				*
Eudorina				*
Phacus				*
Trachelomonas				*
Sarcodina:				
Trinema	*		*	*
Actinosphaerium			*	*
Difflugia			*	*
Euglypha			*	*
Amoeba				*
Arcella				*
Ciliata:				
Euplotes	*	*	*	*
Loxophyllum	*		*	*
Cyclidium			*	*
Chilodon	*			*
Lionotus	*			
Cinetochilum				*
Uronema				*
Vorticella				*
Coleps	*			
Rotatoria:				
Philodina	*		*	*
Coluella			*	
Distylainermis				*
Furcularia				*
Monostyla				*
Gastrotricha:				
Chaetonotus	*			

TABLE VI. Growth of Corixid Nymphs in Aquarium 6

	Ramphocorixa.	Day intervals.		Corisella.
Eggs introduced	Sept. 13			Sept. 13
First instar	Sept. 20	7	6	Sept. 14
Second instar	Sept. 27	6	8	Sept. 20
Third instar	Oct. 3	7	6	Sept. 28
Fourth instar	Oct. 10	6	7	Oct. 4
Fifth instar	Oct. 16	9	9	Oct. 11
Adult	Oct. 25			Oct. 20

the summer, and were in good concentration in the fall. *Corisella edulis* and *Ramphocorixa acuminata* were then reared from eggs (Table VI).

Eggs were introduced into A. 2-7, 11 and 12 on pieces of screen wire (p. 274), about 4 sq. cm., mingled *Ramphocorixa* and *Corisella*. In A. 1, *Ramphocorixa* eggs were on crayfish exuviae; in A. 9, deposited by the water bugs on the aquarium wall. Nymphs hatched in bowls were also transferred to the aquaria (Oct. 24-Nov. 1), following the experiments with eggs, but failed to reach maturity. Observations were made in about 7 in. depth with a 7× binocular above. When changes were noted, the nymphs were drawn out with a large pipette, examined and measured (ocular micrometer: 0.26 mm. at 30×) in a small dish. The limitations of this method must be recognized in the genius for concealment of the minute, transparent first two instars, and in the overlapping of individual life histories. While A. 6 was the only completely successful aquarium, results from the others contributed significant variations considered in the summary.

Variations were also shown in spring rearing experiments with individuals in smaller containers (Table VII). Eggs deposited on *Vallisneria* in a balanced aquarium June 14-15 began hatching June 19. Strips of the plant were placed in deep bowls (B. 2, et al.), and nymphs were obtained; others hatched from crayfish collected June 13 (B. 12, 18, 19, et al.) and June 16 (B. 21, et al.). The bowls were frequently replenished with pond ooze and water.

Summary. The day intervals from eclosion to adult through the five stadia are for *Ramphocorixa acuminata*, 7, 6, 7, 6, 9; and for *Corisella edulis*, 6, 8, 6, 7, 9; in the optimum conditions of A. 6. The success of this aquarium may be considered due to the excellent supply of microörganisms flourishing among the shredded cattail. The rearing experiments of Abbott (p. 252) obtained for our corixid the intervals of 8, 8, 7-10, 7-10, 8 days. Other intervals in the aquaria were: First instar, 8, 9, and 11 days; 2d instar, 8, 9, and 13 days; 3d instar, 6, 6 and 12 days; 4th instar, 9, 10, and 16 days; and 5th instar, 16+ days (died without molting). Table VII should also be consulted. The stadia of *Corisella* showed similar variations, an extreme case being an individual in A. 3 which continued at least 25 days in the 4th instar.

The indications are that the life cycle is like a telescope, with the sections representing the stadia, each independently of variable length, in accordance with the environmental conditions prevailing

TABLE VII. Growth of Ramphocorixa Nymphs in Bowls

	B. 2.	B. 12.	B. 18.	B. 19.	B. 21.
Ovipos'n	June 15	.....	.....	.....	.....
Interval	5 days	.....	.....	.....	.....
First Instar	June 20	June 23	June 23	June 24	June 24
Length	1.4 mm.	1.35 mm.	1.35 mm.	1.4 mm.	1.35 mm.
Width	0.65 mm.	0.65 mm.	0.7 mm.	0.75 mm.	0.7 mm.
Head width	.....	0.55 mm.	0.55 mm.	0.55 mm.	0.55 mm.
Interval	6 days	3 days	5 days	4 days	4 days
Second Instar	June 26	June 28	June 30	June 28	June 29
Length	2.1 mm.	1.9 mm.	1.9 mm.	2.0 mm.	1.9 mm.
Width	1.0 mm.	0.9 mm.	0.95 mm.	1.0 mm.	0.9 mm.
Head width	0.8 mm.	0.75 mm.	0.75 mm.	0.75 mm.	0.7 mm.
Interval	2 days	5 days	5 days	4 days	8 days
Third Instar	June 28	July 3	July 5	July 2	July 7
Length	2.5 mm.	2.5 mm.	2.35 mm.	2.5 mm.	2.35 mm.
Width	1.15 mm.	1.1 mm.	1.05 mm.	1.1 mm.	1.1 mm.
Head width	1.05 mm.	1.0 mm.	0.95 mm.	1.0 mm.	1.0 mm.
Interval	5 days	.....	.....	.....	.....
Fourth Instar	July 3	.....	.....	.....	.....
Length	3.25 mm.	.....	.....	.....	.....
Width	1.4 mm.	.....	.....	.....	.....
Head width	1.2 mm.	.....	.....	.....	.....

at the time.* The period from oviposition to eclosion also varies, 5 days being recorded for B. 2, 8+ days for B. 12, and 10+ days for others. The possibilities for variations must be many times multiplied in the pasture pond environment, subject to abrupt changes of weather and invasion by livestock, with correlative fluctuations in temperature, turbidity, chemical conditions, and food supply.

EXUVIATION

On the bottom of an aquarium containing developing nymphs, specimens are often found firmly attached by the middle legs and humped over, with a mesal cleft along the back from the vertex to the metathorax. Through this opening each nymph must attempt its entrance into the next stadium. Not infrequently it comes to grief; the dead are found in all stages of emergence. The primary instars, at least, must prefer darkness for molting, and are not easily surprised in the process.

Most interesting is the extrusion of the imago. A fifth instar was observed beginning to molt in early evening (Oct. 14), and the adult was just attaining freedom at midnight. The prothorax and anterior margin of the pterothorax of the nymph were tinged deep orange. The wing pads were bright crimson along the sides, due to the compression of the forewings within the transparent pockets. As the

* Compare the results shown by Crowell and McCay (1937), and others in the literature cited by these authors.

dorsomesal cleft widened, the wings appeared. Up to this point, the nymph could be stirred to activity, and would then reattach itself with the middle legs. The wing pads are simple pockets within which are tucked the soft wings; molting draws these slowly forth, gradually expanding. The right wing was free in this individual at 11:35 p. m.—a light orange, transparent sack, longitudinally folded in the middle. With expansion, the forewings became deep tan, with the claval suture showing distinctly white.

5:30 p. m. A nymph observed near the molting point (recognized by the distinct mesal white line on the thorax) was transferred to a bowl in a large pipette. Some force was needed in dislodging it from the pipette. This may have induced a quick molt; the nymph remained on the surface and was free of the exuviae in ten minutes. Tracheal linings trailed from the hull. The shriveled wing tips required an hour for expansion; light spaces, as if air-filled, were at the wing bases and along the claval sutures. Immediately after kicking free of the nymphal shell, the adult carried its wings extending backward, parallel to the body. It submerged and swam about briefly, then returned to the surface and remained there with the forewings at right angles to the body. The hind wings were still unexpanded, resembling crumpled linen. Apparently they dried in this condition, and the insect died on the surface.

Dissection. A fifth instar *Ramphocorixa* was taken from A. 6 and dissected in physiological saline solution. Externally, this nymph showed no abdominal asymmetry, but dissection produced from the loosened, molting skeleton the abdomen of a male with the usual peculiarities. (Note Abbott, 1912.) The forewings, carefully drawn from their pads, were shrunken, but unfolded; the hind wings were folded fanwise, with a crumpled effect. Both pairs were soft and distensible; they were easily expanded with needles, and would not then return to the previous condition. The crimson or deep orange of the forewing pads just before molting is the concentration of tannish color in the shrunken forewing, showing through the transparent cuticula.

The digestive tract seemed quite empty, the malpighian vessels large and darkened. The tract was opened in a drop of the saline solution. Within was a fluffy-appearing mass of cloudy white. Under 20× oculars and high-dry objective, this mass resolved into large cells, rounded and floating free, apparently filled with active bacteria. These organisms seemed also present in quantities within the malpighian tubules, which appeared gray-flecked and much enlarged.

Summary of molting procedure. Exuviation ordinarily occurs at the bottom, on which the nymph anchors itself with the middle legs. The act of molting is presaged by long rests between feeding periods. In the characteristic position, pulsations are observable within the legs. (Note Locy, 1884.)

A white mesal line widens upon the thoracic dorsum. The head swells away from the prothorax; a bubble seems to fill the occipital cup. The prothorax swells apart from the pterothorax, and bends down with the head. The fore part of the tergum is thus strongly arched.

The distinct median suture enters the black fringe on the fore portion of the pterothorax; this splits slowly into halves, and the pterothorax of the next instar bulges forth. The abdomen has become elongate, narrowed, and with a tight appearance. The insect draws itself out by arching movements, and kicks free of the exuviae. In the adult, the prothorax expands after molting, forming the characteristic thin, flat plate.

THE CORIXID DIET

The food of water boatmen has been a much-studied subject for debate. Corixids were described in older textbooks and journals as predators on other water insects (Glover, 1877; Girard, 1885; Cragin, 1899; Howard, 1905; Kellogg, 1905; Smith, 1906; Bueno, 1909; et al.) and even their own kind (Furneaux, 1904). These reports seem to have resulted largely from prejudice, rather than observation; although Howard stated "the beak is strong and sharp and they can pierce the tough skin of one's finger," Bueno noted "an exceedingly hot tongue," and Wood (1884) made similar remarks—lending color to the oft-repeated dictum that *all* aquatic hemiptera are "ferocious" predators. Newman (1835) had indicated the primary inconsistency, describing corixids as carnivorous, but the forelegs "unarmed"; Bueno (1916) suggested they might be herbivorous, since "not fitted with the means to seize living things." Geise (1883) had stated that the barbed mandibular stylets were used to seize simple animals. It remained for Hungerford (1917, 1919) to demonstrate that species of *Arctocorixa* and *Ramphocorixa* may be reared on diets of algae and protozoans, and are thus producers, rather than consumers (as are other bugs), in the aquatic environment. This work has been largely copied since its production—although Martini (1923) and Wolcott (1927) stated that corixids may devour mosquito larvae; Tillyard (1926) described them as

probably almost omnivorous; and Taschenburg (1929) spoke of them as hunting larvae.

In pond and aquarium, in all active stadia, the busy feeding of *Ramphocorixa acuminata* is continuous and energetic. In all their spooning of ooze past the beak, what do the water boatmen secure? To answer this question, adults and nymphs were fixed for laboratory study, and bottom material from the haunts of *Ramphocorixa* was examined microscopically. Even to the unaided eye, this flocculent mass appeared a rich chlorophyll green; protozoans and algae were thickly associated under the lens. Conspicuous among the algae were *Oscillatoria, Anabaena, Merismopedia, Pleurococcus, Achnathidium, Navicula, Amphora, Pleurosigma,* and *Cosmarium;* and among the Protozoa were *Lepocinclis, Pleodorina, Trichoda, Phacus, Amoeba, Colepa* and *Paramecium.* There were also tiny nematodes and rotifers, including *Anurea.* The majority of the organisms might be ingested by the corixids.

Stomach contents from both sexes were examined. The gut was sometimes crowded in gravid females, but a tiny packet of pulverized material was ordinarily obtainable. This was distinctly chlorophyll green, and under the microscope resolved into blue-green, green and golden particles, undoubtedly fragmentations of algal forms; complete specimens of *Navicula, Amphora* and *Oscillatoria* were found. A few complete rotifers (*Distylainermis?*) and many parts were also present. Certain obscure bodies were interpreted as collapsed flagellates and ciliates. The efficient grinder in the pharyngeal region (p. 310) must thoroughly pulverize the majority of the organisms before admission to the stomach. The identifiable remnants were usually from adults, which probably swallow larger, less selected portions than the nymphs. Even so, only empty hulls of the microscopic bodies remained in the stomach; the silicious tests of diatoms were cracked and empty, the rotifers variously ruptured.

Nymphs collected from ponds contained a finely divided mass of chlorophyll green. This was also true of nymphs examined from aquaria in fall rearing experiments. But in adults, remarkable clues to the food organisms of *Ramphocorixa acuminata* were found (Figs. 15, 16). Some were obviously remnants of protozoans and algae, with recognizable fragments of *Scenedesmus* and *Trinema.* Parts of rotifers were abundant, including jaws and feet of *Philodina, Distylainermis,* and other forms.

Summary. The presence of algal, protozoan, and rotiferan re-

mains in adult stomachs indicates for *Ramphocorixa acuminata* a diet neither wholly animal, nor vegetable. The scooping movements of the forelegs seem designed to winnow out of the ooze a nutritious salad from both kingdoms, mixed in one digestible mass in the pharyngeal grinder. The nymphs probably select their food from algae and protozoans, though Abbott (1912) suggested ostracods. They sometimes cling on the backs of other nymphs, but cannibalism has not been observed.

PESTS AND PREDATORS

The lot of the grazer is to feed the carnivore. As producers in the pond environment, the Corixidae must struggle with numerous predators and parasites. Water tigers, crayfish and minnows have been observed attacking and feeding on adult *Ramphocorixa* in aquaria. Backswimmers soon hunt out the water boatmen in small containers; many must fall victim to these rapacious water bugs in pasture ponds (Weed, 1890).

Corixids are fancied by many vertebrates (not excluding man, p. 267). Forbes (1888), in studying the food of fresh-water fishes, found that "true water-bugs . . . were generally rare, with the exception of the small soft-bodied genus *Corisa,* which was taken by one hundred and ten specimens, belonging to twenty-seven species, most abundantly by the sunfishes and top minnows." Corixids are probably third on the preferred bill of fare of the numerous tiger salamander larvae in North Dakota lakes and ponds.* A female *Ramphocorixa* was taken with *Corisella edulis* and *Buenoa* from the craw of a pintail duck. † Our species must be eaten by the birds which feed on relatives in similar environments. Wetmore (1916) listed *Corixa reticulata* from the lesser scaup duck, killdeer, sandpipers, Wilson's snipe, ani, woodpecker and grasshopper sparrow. This corixid made up 57.5 percent of the stomach contents of the lesser yellow-legs at Cabo Rojo (Puerto Rico), and over 50 percent in the blacknecked stilt. Danforth (1926) gave the gull-billed tern, snowy egret, white-rumped sandpiper and ani as corixid eaters. In Kansas, flocks of killdeer commonly haunt the borders of pasture ponds where *Ramphocorixa* are feeding in abundance.

The parasites are not as well recognized. Banks (1939) reported nematodes from *Corixa geoffroyi,* Larsen (1938) in *Cymatia bonsdorffi.* Tiny red hydrachnid mites are sometimes found on *Arctocorixa* and *Ramphocorixa* on the dorsal abdomen under the wings. (Also observed by Larsen on *Cymatia coleoptrata.*) Nymphs are

* Personal communication by Dr. Horace Telford. † By Dr. H. B. Hungerford.

often seen in awkward association with small clams, with the minute shells clamped on the long abdominal fringes or flipping along on the tip of a leg; stalked protozoans (*Opercularia* et al.) are also carried, but the significance of such chance relationships can probably be summed up in *carpe diem.*

OBSERVATIONS IN THE AQUARIUM

Before we leave our study of the life of *Ramphocorixa acuminata,* it may be interesting and profitable to spend a few hours with the water boatmen in a balanced aquarium, where eelgrass, *Elodea* and some tangles of *Spirogyra* luxuriate above a layer of sand covered with rich pond ooze. It is early spring, and the corixids have been taken from the still, cold waters of a pasture pond. The temperature of the aquarium is much higher (23.5° C.), the pH (7.6) about the same. The rectangular five-gallon container stands by a south window; on one side, a 7 × binocular microscope on multiple joints permits the observer to follow most activities within.

SELF MAINTENANCE

March 30, 2:00 p. m. The aquarium is flooded with sunlight; two lumbering snails are plowing along the bottom near a small group of water boatmen, busy and intent on their meals. A male is singled out, furiously digging, sinking lower and lower, until its belly lies on the bottom. The fore tarsi (palae) rotate around one another like twirling thumbs, and between the wide-spread anchoring middle legs a dredge-stream of ooze pours backward. The corixid bobs vigorously, glistening beautifully in the sun; the smooth, streamlined vertexal keel forms a proud crest for this glossily armored underwater knight. The oarlike hind legs at rest extend laterally backward, but are continuously passed forward, across the dorsum, and back along the sides. The film of air over the body must be affected in some way by this action. The hind legs have been observed to pry up the wing tip and press down the abdominal extremity, exposing a silvery air sheet beneath the wings. At intervals, the movements of the palae are interrupted, and the insect seems to contemplate the mass in these twin gathering baskets, as if selecting preferred tidbits.

2:45 p. m. Direct sunlight no longer reaches the aquarium. An uneasy female bats its head rapidly upon the glass, but presently resumes feeding. Another is being stalked by a grim, snaky water tiger, twice as long as *Ramphocorixa.* Its jaws are nearly touching the water boatman when it strikes. The bug almost casually avoids the vicious bite, and re-settles not far away. The beetle

remains motionless for a few seconds, its head twisted in the direction of the corixid's departure, and then trundles into an algal tangle for another strike, its "tail" flipping up with the lunge.

3:15 p. m. The corixids congregate next the window, generally facing the light. A female wildly scurries up the glass wall, hammering with its head and resting momentarily at the surface. A finger tap on the glass frightens it into the twilight of an algal mass, with a hind wing untidily lapped over one of the upper pair.

April 6, 1:30 p. m. A female *Ramphocorixa* is busily feeding in the sunlight, and is quickly buried in the ooze to its belly, bobbing and twirling the palae. The bobbing involves a vigorous dipping of the body with flirts of the swimming legs, and is characteristic both feeding and at rest. The timing now is about one flip of the legs per ⅔ second. The movement may be even more rapid and energetic in feeding individuals, the hind legs flipping back and forth in unison, or alternating. Often a series of swift kicks are given on one side, the other leg pointing out from the body with a slight twitching.

A tiny corixid nymph stirs the ooze beside the female. Almost hyaline, this baby bug is as efficient in its movements as the adult, many times larger. Striped ostracods, the size of the youngster's head, glide by. Neither of the feeders pays any attention to them; they are rapt in their meal of microörganisms. A planarian snakes across the ooze, bumps into some obstruction, recoils violently, and glides smoothly away into the algae, leaving a sinuous path.

2:45 p. m. The sunlight has passed from the aquarium, and a female corixid feeds in the twilight near the glass. The swimming legs are extended laterally, with scarcely a single quick flip per minute. Bobbing movements are more frequent, seemingly induced by the middle pair of legs which are deeply anchored.

Often *Ramphocorixa* brings forward a hind leg and scratches furiously about its head, much like a dog with an offending itch. Similar action may be at the posterior end of the body, or along the sides and back. Sometimes there is an energetic digging about the eye, while the head rolls irritatedly; the nymphs frequently scrub the head with the palae.

An early instar is feeding eagerly, bobbing often and shuttling the palae over the beak. A water tiger passes perilously close to the nymph, but neither shows recognition of the other's presence, and the expected tragedy does not occur.

April 7, 9:40 a. m. Two female *Ramphocorixa* are feeding in a

corner next the window, raising a cloud of ooze. A snail, plowing along the bottom, shoves against the posterior of a corixid which flurries up through the water, returning just behind the snail. The other female approaches, and the two feed amicably together, occasionally touching; they soon separate.

A pygmy corixid nymph feeding nearby makes the characteristic dipping movements, but flirts the swimming legs infrequently. The air film over the body is proportionally less than on the adults.

1:30 p. m. The nymph is feeding in the sunlight next the window, in company with several adult females. Now, with every dip of the body, the hind legs are flipped back on each side. The energy of the tiny bug is amazing; it works without pause, and when not feeding makes short, scuttling dashes—all legs going at once—on an inspection tour up along the glass wall, or into a filmy mass of *Spirogyra*.

In contrast with the vigorous grubbing of the nymph, the adults nearby are quiet in the sunlight. One hangs motionless in an algal mass; the others rest on the bottom with occasional brisk movements of the forelegs. The corixids rise infrequently to the surface; individuals have been under observation on the bottom for more than half an hour. Bubbles rise constantly from *Vallisneria*.

3:00 p. m. For fifteen minutes a water tiger has attempted to capture one of several *Ramphocorixa* feeding in the early twilight of the aquarium. The sinister larva moves rapidly along the bottom, or over an algal mass, on its stout legs, but slows to a deadly, creeping movement when a length away from the corixid. Usually it approaches alongside the bug from behind, turns slowly in until its mandibles are almost touching, and then snaps viciously. Just before the bite goes home, the corixid moves enough to avoid it, and resumes feeding; while the water tiger remains posed for a moment in seeming disappointment. Finally it stalks on, dragging its heavy tail, poking into every hollow, and snapping impartially at whatever it may encounter.

April 8, 1:45 p. m. In the sunlight, two female *Ramphocorixa* and several nymphs are feeding in a depression. This hollow, an inch across and an eighth as deep, has been recently excavated in the smooth aquarium floor, resembling a miniature volcanic crater. With vigorous sweeping of the hind legs, the adults hurl aloft the silt and debris. In this they are undisturbed by a snail descending into the crater.

June 18, 8:30 p. m. Within the aquarium, indirectly lighted with a shaded bulb, a small crayfish has emerged from its den and forages

in the shrubbery of algae and eel-grass. The antennae lash about, the eyes bulge inquisitively. The cruising to and fro of the corixids often brings one in front of the crayfish, which grasps eagerly at the elusive bugs with big tweezers and small. These attempts seem clumsy, but several of the corixids are devoured in the night. As observed, the water boatmen frequently appear unconcerned by the slow approach of predatory menaces, and it is certain that Fate does not always play with them against their enemies.

MATING

June 16, 11:25 a. m. A male attaches itself to a female before the microscope. The end of the male abdomen is thrust out, twisted about and down to the left, curving in and around to join with the female genital apparatus. The male holds closely to the back of the female, clinging with the forelimbs (the palae grasping the margins of the female upper wings near the bases) and the genital arrangements. The prominent cephalic keel lies with its apex on the posterior margin of the female pronotum. The whole body of the male, excepting the wings, appears curved in the lateral view. Both sexes hold the wings in normal position. The activity of the female during the first half hour contrasts with the patient quietude of the male. An occasional flirt of the swimming legs, thrust out to the sides, and slight trembling of the posterior are the only movements of the male. The head is tucked down, so that large silvery air bubbles mark the junctures of the pronotum with the head and scutellum.

The female feeds almost constantly during the first half-hour, moving rapidly here and there, but with intermittent cessation of all movement except occasional beats of the hind legs. The clinging legs of the male drape loosely backward, past the abdominal tip of its mate.

Five minutes after attachment, the female ascends to the surface and returns instantly. In the last ten minutes, it ceases feeding, though continuing its darting movements on the bottom. Finally the female swims upward among the leaves of ell-grass, separation occurring at 12:05, about four inches from the bottom. The male immediately returns to the bottom; the female rests for a moment on a strip of *Vallisneria*, and then swims down. Eggs have been laid in the aquarium June 14 and several days following.

August 25, 11:30 a. m. A male and female are in copula before the lens, the position as described. The male is also flirting the swimming legs, often in unison with the female. The latter bobs

and feeds actively, frequently changing position, and once making a quick trip to the surface. Presently the two remain motionless for a minute or more, undisturbed by the presence of another female which alights upon the back of the male where it clings for a moment.

Eggs have been laid in the aquarium through the past forty-eight hours. The transparency of the corixid cuticula reveals the dim outlines of the eggs in the females, as well as other internal structures in adults and nymphs. It is possible to determine with a hand-lens in the field when the females are about to lay; when they are well-packed with eggs, oviposition usually occurs within a few hours and through several days following entrance in the aquarium.

OVIPOSITION

August 23. Numerous adults and nymphs (3rd, 4th and 5th instars) of *Ramphocorixa acuminata* have been collected from the shallows of a typical pasture pond (9:00-10:00 a. m., 78° F.). Placed in the balanced aquarium (10:45 a. m., 80° F.), they swim about and bob on the bottom. The vigorous dipping of the body is not necessarily accompanied by feeding, but most of the corixids are soon stirring the ooze with twirling palae. A small red flowerpot is sunken in the middle of the aquarium, and several corixids feed in the shadow of the rim.

11:30 a. m. A female before the microscope lays two eggs on the vertical rim of the clay pot. The corixid clings with the middle legs in the shadow, horizontal and facing west. It is motionless for several minutes, then flips the swimming legs rapidly and makes adjusting motions with these at the tip of the abdomen. The abdominal apex is then pressed against the smooth surface of the pot with a brief smearing movement, the apical plates spreading conspicuously. The abdomen lifts with trembling, swaying motions, and the egg slips out smoothly, erect on its pedestal, with the incurved (dorsal) side toward the female. Within the next minute, the corixid hops with quick flirting of the swimming legs and adjusting movements at the abdominal apex to a new position about one-fourth inch to the west, where another egg is deposited, precisely as before.

Meanwhile, three eggs are laid by another female an inch to the east, facing in that direction; and five eggs are placed on a runner of *Vallisneria.* All eggs are within an inch from the bottom and bend in all directions.

12:10 p. m. A female oviposits on a leaf of *Vallisneria,* facing up on the shadowed side, about two inches from the bottom. Again, there are quick flirting movements and adjustment of the abdominal apex by the swimming legs, and trembling, swaying motions of the abdomen with deposition of the egg. In all cases observed, the egg slips out in one or two seconds after these characteristic motions begin.

Within the next twenty-four hours, numerous eggs are deposited on *Vallisneria,* the rim of the flowerpot, and the glass wall of the aquarium. Many corixids of both sexes have perched without oviposition on the limbs, rostrum, carapace and telson of two crayfish fastened (footnote, p. 274) in the aquarium for several hours.

PART 3—THE SKELETAL STRUCTURE OF THE WATER BOATMAN

"The simplest and most satisfactory explanation that can be given. . . . A morphological interpretation cannot be fully acceptable unless it is consistent in all its implications."—Snodgrass (1938).

It is surprising to find how few and brief have been the morphologic studies of Corixidae—a familiar, widely distributed family of water bugs with remarkable structural adaptations. The attractive features of the group have been well recognized, but expressed for the most part in taxonomic and ecologic studies possible with a minimum of morphologic interpretations. Yet few insect groups offer opportunity for more convincing observations and absorbing reflections on the extensive remolding of a generalized structural plan, correlative with the requirements of a special way of life.

Extreme specialization, characteristic among Hemiptera, does present difficulties in homologizing with more generalized orders. The works of Crampton, Weber and Snodgrass are most significant and encouraging in pointing out fundamental relationships, the structural clues which facilitate this task.

Based largely on the principles discussed by these authors, this introductory study will attempt descriptive identification of skeletal areas in *Ramphocorixa acuminata.* Though small, this corixid is an attractive subject with clear integument and unelaborate coloration. Some attention has been given to species of *Arctocorixa, Corisella* and *Trichocorixa.* The larger of these have been welcome comparative material, lending definition to parts obscure in the smaller species. Comparisons with more generalized hemipterans are given in the discussions of suggested homologies.

The head of Corixidae has received most of the morphological consideration given this Family. Usually discussions have centered on the curious beak (rostrum). Rösel (1755), Latreille (an 5 de la R.!), and Lamarck (1835) noted the peculiarities of this structure. Detailed studies of the mouthparts were made by Geise (1883), Börner (1904), and Hungerford (1919)—continued by Poisson and Jaczewski (1928), Ekblom (1930), Hansen (1930) and others. The beak has been discussed briefly in the several accounts of the food-getting habits and stridulation. Studies of the latter have been summarized by Butler (1923) and Mitis (1935). Aspects of face, vertex, pronotum, elytra, palae (fore tarsi) and genitalia commonly appear in taxonomic papers. Other representative writings are by Mecznikow (1866) on the embryology; Hagemann (1910) on the tympanal organ; Bedau (1911) on the compound eye; Rousseau (1921) on the nymphal structure; Brindley (1929) on the repugnatorial glands; Singh-Pruthi (1925) and Larsen (1938) on the genitalia; Elson (1937) and Spooner (1938) on phylogenetic comparisons; Banks (1939a) on the cephalic glands; and the sections on Corixidae in the general works of Schröder (1925, 1928, 1929), Weber (1930, 1933), Karny (1934) and Beier (1938)—all excellent digests of contributions of interest and value on structural details.

A full morphologic study of a representative corixid has not been completed. It is hoped that the pages following may contribute some measure of basic information toward that end.

THE CEPHALIC SKELETON

In the lateral view, the large corixid head is compressed in an opisthognathous caplike position on the prothorax. This conspicuous overlapping feature was considered by Crampton (1921), together with other resemblances in the head capsules (1932), to be indicative of the relationship of corixids and other hemipterans to the Psocidae. In the anterior view, the head is distinctly triangular, with the large compound eyes occupying the dorsolateral angles and thus the greater part of the width (Figs. 18, 21). In those species examined, the length and width of the head are approximately the same—nearly equal to the width, and about one-third the length, of the body (Table VIII).

The males of all species examined are smaller than the females, and the heads are proportionally reduced. The lateral borders of the male heads curve in more sharply below the eyes, so that the face appears narrower. It is also flattened or depressed in contrast with the tumid face of the females. The male vertex seems more

TABLE VIII. Measurements of representative Corixidae *

SPECIES.	Lengths.		Widths.		
	Head.	Body.	Head.	Body.	Between eyes.
Arctocorixa scabricula	3.8 mm.	11.4 mm.	3.8 mm.	4.7 mm.	1.4 mm.
Arctocorixa sp	3.2 mm.	10.1 mm.	3.3 mm.	4.0 mm.	1.2 mm.
Corisella edulis	2.4 mm.	8.3 mm.	2.5 mm.	2.9 mm.	1.1 mm.
Arctocorixa alternata	1.8 mm.	6.6 mm.	2.0 mm.	2.1 mm.	.7 mm.
Ramphocorixa acuminata	1.8 mm.	6.3 mm.	1.8 mm.	2.0 mm.	.7 mm.
Trichocorixa sp	1.5 mm.	5.3 mm.	1.5 mm.	1.6 mm.	.6 mm.

* Female specimens. Limitations of ocular micrometer = 0.3 mm. at 42.5x. Lengths—*head*, in lateral view, from vertex to tip of rostrum; *body*, from anterior margin of head to tip of abdomen. Widths—*head*, across frontal region, between lateral angles of eyes; *body*, across widest portion of abdomen, excluding wing edges; *between eyes*, across narrowest portion between inner facial angles.

elevated above the level of the eyes; in *Ramphocorixa* this elevation culminates in a sharp point. The most evident sexual dimorphism is shown by *Ramphocorixa acuminata*, the females having even contour across the eyes and the vertex (Fig. 21). The males have the prominent specific character of sharply acuminate heads (Figs. 17, 18). The anterior surface of the vertexal point is flattened; the posterior surface bears a "keel." The acumination is much reduced in *Ramphocorixa rotundocephala* Hungerford (1927), but a small point remains as an indication that this peculiar dimorphic condition of the head is characteristic of the genus.

The greatly expanded corixid vertex (Figs. 20, 21, Vx) is formed by the dorsal junction of the parietals, or lateral cranial areas, at the median coronal suture which shows in the nymphal head (Fig. 8, cs). The parietals, bearing the compound eyes and antennae, flank the facial frontoclypeal and paraclypeal areas (Fig. 21, Fr, Clp, PrClp) and the occipital areas and foramen (Fig. 19, Oc, For) on the posterior surface, where the suboccipital bridge (Soc) completes the cranial rim uniting with the rostrum (Ro).

The association of oral appendages in Corixidae has been considered of major taxonomic importance in its peculiarities—Börner (1904) assigned the Corixidae to the Suborder Sandaliorhyncha with especial reference to the rostrum. Among Insecta the labrum is essentially procephalic, a cranial prestomal flap (Levereault, 1936), though commonly treated with the mouthparts which are properly gnathocephalic. In Corixidae, and other Hemiptera, the mandibular and maxillary plates and the basal portions of the labium also fuse into the cranial wall. The apical portions of the labium form the

rostrum (Figs. 19-21, Ro)—a small cup surrounding the labrum, the distal parts of the mandibular and maxillary stylets and plates, and the hypopharynx.

The details of the head skeleton may be discussed conveniently in two major divisions—the Cranium and the Rostrum, with associated ingestive structures.

THE CRANIUM

Frontoclypeal Areas. Two parallel vertical lines partially divide the ventral facial region into approximate thirds (Fig. 21, pcs). The lines are dorsal continuations of lateral sinuate horizontal inflections and end abruptly in the middle facial region. In cleared or dissected heads, a curved bar (Fig. 25, h) appears connecting the end point of each surface groove with the corresponding side of the masticating chamber (Mr) just above the sucking pump (Pmp).

The rostrum is easily removed from heads cleared of muscles and softened with caustic potash (or soda). This exposes the small pointed labrum (Fig. 25, Lm), fused dorsally with the clypeus. The bulky inverted T of the clypeus may then be lifted free, parting from the head along the sinuate horizontal lines to the dorsal extremities of the vertical lines. It is apparent that these lines represent the adjunction of two walls, the inner clypeal overlying the inflections of the lateral head walls. The curved dorsal bars are the dorsolateral junctions of these walls which extend into the sucking pump and are hinged proximally to work upon one another in the action of that food passage.

The frons (Fig. 21, Fr) is fused with the dorsal clypeal area between the end points of the vertical lines. In general, this relation, and the identity of the clypeus (Clp), may be established by examination of the attached muscles.* These are in three overlapping groups (Fig. 22, dlcb, dlbc, dlphy). The ventral group (dlcb) extends from the area bounded by the vertical lines, and just below, to the anterior wall of the sucking pump (Pmp). This typical hemipteran food tube is described by Snodgrass as derived from the cibarial passage of the primitive insect head. The muscles activating the pump are the cibarial dilators which attach on the clypeus. The corixid clypeus is unique (Spooner, 1938) in the hollow lateral extensions, overlapping ventral inflections of the paraclypeal areas (mandibular plates, p. 303). These extensions, and a part of the ventromedian clypeal area, represent the anteclypeus (tylus) of other Hemiptera.

* Heads may be cleared and studied in thyme oil or xylol, with allowances for muscle shrinkage. These studies are supplemented advantageously with thick sections cut in celloidin.

The vertical lines do not arch upward and join on the median face, as often figured. Such an arch *seems* indicated by differences in surface elevation where the two dorsal groups of muscles (Fig. 22, dlbc, dlphy) are attached. These muscles extend inward to the masticator (Mr; Geise's kaukästchen, 1883) which is evidently derived from buccal and pharyngeal regions of the stomodaeum. The position of the frontal ganglion (FrGng) and its connectives clearly places one set of muscles (dlbc) with the ventral series, representing buccal dilators attaching on the clypeus. The frontal ganglion connectives loop back around the remaining set (dlphy), and these muscles are therefore pharyngeal dilators attaching on the frons.

Lacking the epistomal suture, the distinction of frons and clypeus is at best artificial. However, while the defining muscles in the corixid overlap in the lateral view, from the front they are separable, the thick pair from the pharynx forming dorsolateral crescents above the others. Defined strictly by the pharyngeal dilators, the frons would be limited to the area marked by these crescents; but there is probably an indeterminate dorsomedian extension. The frons has been considered to include the space between the compound eyes, separated from the vertex by "epicranial arms" (Spooner, 1938) apparent in the nymph. This opinion is convenient, but inconsistent with the relations of ocelli (Diaprepocorinae), compound eyes and antennae to these sutures.

Parietal Areas. The position of the epicranial suture—that is, the persistent molting line—is clearly indicated on the nymphal vertex. The mesal, or coronal, line (Fig. 8, cs) branches into definite sutures (pfs) extending ventrad along the inner margins destined to be reached by the compound eyes of the adult. The outlines of the adult eyes are plain in cleared nymphal heads (5th instar), with the characteristic inner border of setae mesad of the epicranial branches. The sutures are well separated from the nymphal eyes, curving around the inner ventral corners and down to the head rim above the antennae. The downcurve below the eyes remains in the adult (Fig. 21, hos) along the facial edge of an interesting strut (p. 304) setting off small triangular hypocular areas; the rest of the suture disappears.

Corixine nymphs show rudiments of latero-dorsal ocelli beneath the cuticula (Fig. 8, o) in the position found in the adult Diaprepocorinae (Fig. 10). These structures are definitely ventral to the epicranial fork. In the generalized head, ocelli are typically postfrontal in position. The excellent series of hemipteran heads figured

by Spooner (1938) often shows the "epicranial arms" posterior to the ocelli and extending laterad of the antennae; by extension of the sutures around the corixid head rim (Figs. 19, 21, hos), a like condition is suggested. True frontal sutures must pass mesad of the antennae toward the mandibular articulation (mda).

In view of the available evidence, the epicranial branches in the corixid nymph are probably postfrontal sutures without boundary significance. Frons and vertex merge indistinguishably, unless the attachments of pharyngeal dilators are considered limiting. The vertex probably includes the whole expanded upper portion between and behind the compound eyes, representing the dorsal junction of the cranial halves, or parietals. Inner membranous structures also suggest this condition. Visible through the cuticula and forming an apparent mesal line, membranes in connection with the aortic sinus partially divide the shallow cavity of the head above the dilator muscles into two lateral compartments. Within these lie the apexes of the large cephalic, or maxillary, glands.*

Four rows of setae are regularly present on the vertex, two bordering the inner margins of the eyes, two near the mesal line (Fig. 4). These extend into irregular groups of setae below the eyes and on the vertexal margin above the occipital aspect. The inflections surrounding the eyes do not set off ocular sclerites; the clear marginal facets are misleading. Levereault (1937) has discussed this "optical illusion."

The paraclypeals (Fig. 21, PrClp) of Hemiptera have been termed the juga or lora, and homologized with the mandibular plates of Homoptera and postclypeal or genal areas. The developmental studies of Heymons (1899) gave impetus to the former opinion, and those of Muir and Kershaw (1911, 1912) to the latter. The controversial history was traced briefly by Hamilton (1931) and Spooner (1938), who presented a series of head capsules to indicate progressive development of the paraclypeal areas from the postclypeus. Snodgrass (1938) showed their derivation from the mandibular plates. In the corixid, the lateral extensions of the clypeus overlap ventral inflections of the paraclypeals which give attachment to protractor muscles from the mandibular levers (p. 309). The inflected portions are evidently mandibular plates, as shown by the muscle connections and the articulations with the levers (Figs. 19, 21, mda). The uninflected paraclypeal areas fuse with the lower parietals, or genae (Figs. 19-21, Ge), below the compound eyes.

* Described in the Corixidae by Elson (1937) and Banks (1939); in *Belostoma* by Locy (1884); in *Notonecta* by Bordas (1905); in *Nepa* by Bordas, and Hamilton (1931). Poisson (1924) mentions maxillary glands in corixids, notonectids and naucorids.

The parietals on the posterior surface include the expanded vertex (Fig. 19, Vx) above the occipital foramen and the ventrolateral areas (Ge) bearing the antennae. The vertexal surface is concave, fitting over the prothorax. In the nymph, it is halved by the coronal suture, continued from the facial surface. The mesal suture is marked in the adult by a persistent indentation between converging groups of setae on the head rim behind the eyes. The cuticula is generally thickened in the deep concavity of the vertex where it impinges on the rounded anterior surface of the prothorax. The dilator muscles of the postpharyngeal expansion of the alimentary canal (Fig. 22, dlpphy) attach on the vertex just above the occipital foramen, and the retractors of mandibular and maxillary stylets attach in the vicinity laterad.

The lower parietals, or genae (Fig. 19, Ge), bear short, four-segmented antennae (Ant). The antennal socket (Fig. 26, As) is oval and tilted up toward the head rim. The antennifer is represented by an inner dorsal thickening on the marginal inflection. The scape (Scp) is longer than the pedicel (Pdc) and curved upward. The third segment, or first segment of the flagellum (Fl), is club-shaped, and as long as the first two segments; the apical segment is awl-shaped and shorter. Only the basal segments are distinct in the nymph.

The upper and lower parietals are partially separated in the occipital aspect by an inflection slanting down from below the eye (where the postfrontal inflection of the facial surface intersects the head rim) to a position above the antennal socket (Fig. 19, hos). Within the angle of the converging lateral head walls, the anterior and posterior inflections are continuous, forming a sturdy hypocular strut (Fig. 26, Hos). The derivation of this structure may be demonstrated in heads cleared and softened with caustic potash. The lower area shielding the antenna easily separates along the double-walled inflection as a fenderlike extension of the gena, fused dorsally with the in-turning cranial wall below the eye to form the hypocular strut.

Occipital Areas. The true occiput of the generalized insect head arches over the occipital foramen between the occipital and post-occipital sutures. In the frequent absence of the former suture, the occipital arch is rarely well-defined and is often considered synonymous with the posterior cranium. In Hemiptera, and other orders, the arch is sometimes lost in the encroaching parietals. The ventral occiput, or postgenae, of Corixidae (Figs. 19, 20, Oc) fuses

dorsally with the vertex and the postoccipital rim beside the foramen; laterally with the genae; and ventrally enters into the surficial maxillary plates (Mxpl) and the suboccipital bridge (Soc) below the foramen. The lateral (anterior) limits may be indicated by a line drawn from the dorsal postocciput to the mandibular articulation (mda). Below this point the cephalic gland opens (cgo) on the margin of the maxillary plate next the lateral extension of the clypeus (Clp) overlapping the head rim below the gena. The plates and the suboccipital bridge are considered in the discussion of ingestive appendages (pp. 306-308).

The Postocciput (Fig. 19, Poc). The postoccipital rim surrounds the ovate occipital foramen, or foramen magnum (For), fitting closely into the anterior hollow of the prothorax. A dorsal ledge (r) receives muscles from the mesothoracic phragma (Fig. 41, 1Ph), and prothoracic muscles attach upon lateral processes of the rim (Figs. 19, 20, pr). These muscles vigorously activate the head in feeding and use of the air supply. Similar muscle attachments upon the cervical sclerites of the generalized insect head may suggest the derivation of the lateral processes. The corixid cervix is reduced to the short membranous tube joining the head directly to the prothorax; ventrolateral thickenings of the postoccipital rim (cva) meet in extrinsic articulation with ventral prolongations of the prothoracic episterna (Fig. 35, cva).

THE ROSTRUM AND INGESTIVE STRUCTURES

The Labium. The corixid beak, or rostrum (Figs. 19-21, Ro), is formed by the pyramidal labium (Fig. 22, Lb), overlapping the labrum (Lm) and thus enclosing the apical hypopharynx and distal mandibular and maxillary parts. (The development of this relationship was described by Mecznikow, 1866.) The labium is broadened in union with the suboccipital bridge, the external maxillary plates and the ventral ledge of the clypeus. The posterior surface contour of the subocciput continues on the labium—a broad mesal elevation sloping to the lateral margins. The anterior, or facial, surface is evenly curved and transversely grooved, with a mesal indentation where the lateral areas adjoin (Fig. 34). This line of fusion is interrupted at the rostral tip by the oral apparatus (lbo).

The lateral margins of clypeus and rostrum are heavily bearded (Figs. 17-21). The long anterior setae thrust downward; the posterior thrust outward, and a line of finer setae parallels the rostral margin. On the apical posterior surface, the mesal elevation is tipped with a long goatee and immediately truncated. The triangu-

lar face of the truncation is distinct from the oval tip of the anterior surface pierced by the oral opening (Figs. 20, 21, lbo). Lateral fans of short setae project across the lower bulbous surface of this area (Fig. 34). The rostral setae are probably of service in combing and sifting food organisms from the twirling palae (p. 320).

The extended labium of the hemipteran beak has long challenged researchers in its relations to the generalized type (Geise, 1883; Wedde, 1885; Leon, 1887; Smith, 1892; Marlatt, 1895; Heymons, 1899; Muir and Kershaw, 1911; Bugnion and Popoff, 1911; Tower, 1914; Snodgrass, 1927, 1938; Weber, 1928; et al.). The interesting historical accounts of Leon and Weber are particularly recommended. In summary it may be noted that Crampton (1928, cf. 1929) figured a series of modifications through several orders to show derivation of the apical segments from fused labial palpi and palpigers, supported by the basal mentum attached to the suboccipital gula.

In turn, the corixid rostrum is oddly modified from the usual hemipteran condition in its segmental and suboccipital relations. Comparison with *Notonecta* shows proportional broadening and shortening of the apical labium, and fusion of the posterior basal portion with the suboccput. The probable dorsal boundary in this region may be indicated by lines drawn between the cephalic gland openings (Fig. 19, cgo) and the transverse median groove (g). The true suboccipital bridge (Soc), including the median gular area and lateral extensions inward from the lower occipital areas, must lie above the groove. Attached within is a curious median shaft (Fig. 22, 24, Lbs) slanting forward to unite with the anteromesal labial wall (the invaginated floor of the inner labial cylinder) near the apex of the hypopharynx (Hphy). The shaft has been considered a tentorial structure (Börner, 1904); another view of its derivation and some insight on segmental relations may be given by comparing median sagittal sections of corixid and notonectid heads (Figs. 22, 23).

In *Notonecta* (Fig. 23), the long, four-segmented labium (Lb 1-4) forms a piercing beak. The sides curve forward, enclosing the mandibular and maxillary stylets in a deep groove, covered by the labrum (Lm) in the basal segment and sealed over in the apical three segments. Where the stylets enter the sealed-over channel (Lbcy) in segment two, a broad median shaft (Lbs) from the anterior labial wall slants in toward the posterior basal edge of the labium within the suboccipput (Soc.). Four median groups of muscles on the shaft

—two (Mcl A, B) attaching on the posterior basal edge of segment three, two (Mcl C, D) attaching on the median anterior wall of segment one—serve with others in the movements of the apical labium. The salivary meatus (sm), or exit duct, enters from the syringe (Syr) between the tip of the hypopharynx (Hphy) and the anterior mesal groove in the basal labial segment.

In the corixid (Fig. 22), the apical segments of the labium form a rostral cup thrust back upon the cranium covering the apical hypopharynx (Hphy) and the labrum (Lm) to the margin of the clypeus (Clp). The apexes of the mandibular and maxillary stylets pass between the inner labial and lateral hypopharyngeal walls. Where the stylets converge and enter the short cylinder (Lbcy) leading to the orifice (lbo), the median shaft (Lbs) from the anterior labial wall slants in to unite with the subocciput (Soc) just above the transverse median groove (g). Two groups of muscles on the shaft attach (Mcl A) below and (Mcl B) above a short transverse ridge (Lb_{3b}) within the posterior median wall of the rostrum.

Thus comparison of the corixid with the notonectid suggests the derivation of the median shaft (Fig. 22, Lbs) within the labium as an apodeme from the anterior wall at the junction of segments one and two. The two posterior groups of muscles (Mcl A, B) on the shaft, if homologous, are reversed proportionally when compared with the notonectid, but retain the same general relations to the inner basal ridge of segment three, though the ventral group (Mcl A) spreads considerably from this point. The anterior muscles on the apodeme in the notonectid labium (Fig. 23, Mcl C, D) are absent from the corixid, the shaft (Fig. 24, Lbs) fusing solidly (at) with the anterior labial wall (Lb) behind the apex of the hypopharynx (Hphy). The thrust of the apodeme into the cranium carries it beyond the salivary syringe (Fig. 22, Syr), though the salivary meatus (sm) is much elongated between the hypopharynx and the labial wall. Small muscles join the lateral hypopharyngeal processes (Fig. 29, pr) and the ends of the transverse median groove (Fig. 24, g) in the subocciput. These connections suggest the larger muscles which join the hypopharyngeal processes and the posterior basal ridge of the second labial segment in the notonectid.

Consistent with the indicated segmental homologies are the relations of the corixid labium and the maxillary plates (discussed below), and the mechanism of the rostral apex. The bulbous circumoral area (Fig. 34) bears an interesting arrangement of sclerotic bars (br). The lateral angle of the upper triangular figure on either

side of the orifice (lbo) is connected by muscles (dlbo) to the dorsal posterior corner of the rostrum; contraction of the muscles widens the opening (Hungerford, 1919). The counter movement is induced by the elasticity of the cuticula, assisted by muscles (Fig. 33, clbcy) reaching from the posterior labial wall, beside the median muscles from the labial shaft, to sclerotizations of floor and wall of the apical labial cylinder (Lbcy). The muscles of the inner cylinder and its orifice, controlling the passage for the mandibular and maxillary stylets, are significantly like those with similar function in the distal third segment of the notonectid labium.

Maxillary and Mandibular Parts. In the backswimmer, the lateral openings of the cephalic, or maxillary, glands are found on the posterior boundaries of the maxillary plates. The anterior borders of the plates are inflected beneath the clypeus, continuing along the basal anterior labial wall into the hypopharyngeal processes on either side of the salivary syringe. The protractor muscles of the maxillary stylets attach on the inflected portions of the plates in pouches formed by folds over the maxillary and mandibular stylets against the lateral hypopharyngeal walls. (See Heymons, 1899, and Butt, 1943.)

In the water boatman (Fig. 19), the same general relationships are found, though the maxillary plates (Mxpl) are almost wholly inflected beneath the lateral extensions of the clypeus (Clp) anterior to the cephalic gland openings (cgo). The plates taper toward the middle (Fig. 29) into little more than marginal thickenings on the basal anterior labial wall and the attenuated hypopharyngeal processes (pr). The protractor muscles of the maxillary stylets (pmx) attach on these margins.

The maxillary and mandibular stylets, or bristles, of Corixidae are shorter and less closely bound together than usual in Hemiptera. From the extremities, commonly showing in the rostral orifice, the two pairs of stylets (Fig. 29, MxS, MdS) may be traced through the apical labial cylinder and into the cranium on either side of the hypopharynx, in the space between the basal anterior labial wall (Lb) with the attached inflected portions of the maxillary plates (Mxpl), and the lateral hypopharyngeal walls with the attached inflected portions of the mandibular plates (Mdpl). The retractor muscles (rmx, rmd) of the stylets attach on vertexal areas laterad of the dorsal postoccipital rim.

The maxillary stylets (the inner pair) show apical differences. The right stylet (Fig. 30) is broad-bladed, with the inner surface

hollowed; the left (Figs. 31, 32) seems curiously twisted, with a flap of the anterior edge over the deeply hollowed inner surface. When the two apexes, freely movable on one another, are thrust out together, the hollow of the right claps over the twisted left, forming a tube. This may serve in sucking, or working, material into the sucking pump, and may receive the secretion from the salivary syringe. Food and salivary canals, found in the fascicle of stylets in other Hemiptera, are not differentiated in Corixidae (Geise, 1883; Börner, 1904; Weber, 1930; Elson, 1937; et al.). The tips of the maxillary stylets are roughened and may serve in rasping and prehension.

The mandibular stylets (the outer pair, Figs. 27, 28) are of more purpose in piercing and holding organisms (as observed by Geise, 1883). These instruments are apically similar, spear-like and armed with several anterior teeth sloping proximad, and probably have a shuttle-like action in securing food and scraping it into the functional mouth. The cranial attachments emphasize the suggestion of implemental activity and power. Each stylet is united to a triangular mandibular lever (Fig. 27, mdl) at the mesal angle (Fig. 28, m); a sclerotic bar extends from this point up into the dorsal angle (d) and down into the lateral angle (l) where it forks into anterior and posterior articulations (Fig. 27, ca) with the cranial wall (Figs. 19, 21, mda). Protractor muscles (Figs. 25, 29, pmd) attach on both surfaces and reach into the pouch formed by the inflected ventral paraclypeal area, the mandibular plate (Mdpl), which continues into the lateral hypopharyngeal wall (Snodgrass, 1938).

The Sucking Pump. The hemipteran sucking pump has been shown by Snodgrass to be derived from the cibarium (preoral cavity) of the generalized insect head. In the corixid (Fig. 22, Pmp), the inner surfaces of labrum (Lm), clypeus (Clp) and hypopharynx (Hphy) are involved. The true mouth (Mth) and pharynx (Phy) are deep within the cranium, the latter posterior to the frontal ganglion (FrGng). The terms epipharyngeal and hypopharyngeal, generally applied to the anterior and posterior surfaces of the sucking pump, hold over from authors identifying the structure with the pharynx.

The corixid labrum (Figs. 22, 24, Lm) is a snoutlike cranial projection within the rostral cup below the clypeus (Clp), fitting over the tonguelike apical hypopharynx (Hphy). The united sclerotic tips of labrum and hypopharynx form an opening from the apical

labial cylinder (Fig. 22, Lbcy) into the sucking pump (Pmp). The plunger of the pump is the inner (epipharyngeal) wall of labrum and clypeus, the latter activated by the usual cibarial dilators (dlcb). The cup, or sitophore (Snodgrass, 1938), of the pump is the hypopharyngeal wall. These walls hinge dorsally in lateral bars beside the entrance to the masticator (Mr). The pump sucks in material as the cibarial muscles lift the epipharyngeal plunger; the material is forced into the pharynx as the elastic plunger presses again into the hypopharyngeal cup, acting from the narrower distal to the wider proximal end joining the masticating chamber. Lateral epipharyngeal hairs slant toward this entrance, directing the material to the middle and preventing backflow.

The Masticator. The action of this unique grinder (Figs. 22, 25, 29, Mr) is similar to that of the sucking pump. Two groups of muscles pull out the forward wall of the sclerotic box, which snaps in again on relaxation of the dilators. The inner surfaces of the masticator are toothed and spined, indicating its function in the ingestion of the varied corixid diet (Geise, 1883; Börner, 1904; Poisson and Jaczewski, 1928; Weber, 1930; et al.). The organ does not appear in the liquid-feeding *Notonecta* (Fig. 23, Phy), where the sucking pump (Pmp) is strongly developed.

The corixid masticator (Fig. 22, Mr) is derived from the posterior cibarial, or buccal (Mth), and the anterior pharyngeal (Phy) regions, as indicated by the dilators. These muscles attach by two median tendons, and are separated by the frontal ganglion (FrGng) into prefrontal, or clypeal, and frontal series (p. 302). The foremost group (dlbc) probably represents the buccal dilators, acting upon the region of the true mouth; the posterior muscles (dlphy) are pharyngeal dilators. The posterior pharynx (Pphy) bends sharply horizontal, with dilators (dlpphy) attaching on the vertex and postoccipital rim above the occipital foramen, and continues into the slender tube of the esophagus (Es).

The Salivary Syringe. The apical hypopharynx (Fig. 22, Hphy) is hollow and tonguelike (the lingua, Snodgrass, 1938), thrust out over the basal anterior labial wall below the apical inner wall of the labrum. The anterior hypopharyngeal wall continues dorsad as the sitophore of the sucking pump; the posterior wall is united with the labial base where the marginal attenuations of the maxillary plates fuse into the hypopharyngeal processes (Fig. 29, pr). Between these thin extensions, the salivary syringe (Syr) is attached to the basal posterior hypopharyngeal wall. The structure is a small cylinder

fitted with a piston, dilator muscles (dlsyr) attaching on the hypopharyngeal wall of the sucking pump. When the cylinder is expanded by contraction of the dilators, the secretion of the salivary glands, located in the thorax over the esophagus, enters the posterior wall of the chamber through a pair of salivary ducts (Fig. 22, dct). The piston, snapping back into the cylinder, closes these ducts and forces the secretion out through the salivary meatus (sm). This tubule passes between the anterior and posterior hypopharyngeal walls to the apex. The secretion may then enter the hollow of the maxillary stylets within the inner labial cylinder (Lbcy).

THE THORACIC SKELETON

The thorax of Corixidae conforms smoothly to the streamlined plan of the body. With strong walls supporting the neat arrangement of inner struts and glistening muscles, the whole effect is of compactness and efficiency comparing favorably with the swift, graceful backswimmers.

The thoracic mechanism is chiefly remarkable for the advanced specialization of the appendages. These are fitted perfectly to the locomotor and ingestive requirements of active aquatic insects subsisting on ooze organisms. The forelegs are designed specifically for ladling ooze, the middle legs for clinging, the hindlegs for swimming. Two well-developed pairs of wings are regularly present. (The hind wings are reduced in some Corixidae.)

The *prothorax* (Figs. 35-38) is closely attached to the head by the narrow membranous neck, and usually separates off with the head in dissection. The loose membranous connection with the mesothorax permits the variety of prothoracic movements incidental to ingestion and respiration. The wing-bearing segments (meso- and metathorax) are joined compactly as the *pterothorax* (Figs. 39-41), firmly united to the abdomen. The neck, or *cervex*, is fundamentally intersegmental (Crampton, 1917), though parts are probably derived from the labial and prothoracic segments (Snodgrass, 1935). It is discussed in this section as an introduction to the prothorax.

THE CERVIX

The corixid cervix (Fig. 42, Cvx) is the short, tubular intersegmental membrane joining the postoccipital rim of the head within the anterior hollow of the prothorax. The cervical wall encloses the dorsal shelf (Fig. 19, r) and lateral processes (pr) of the postocciput, surrounding the occipital foramen (For). Below the processes, the membrane passes to the inner margin of the rim, exposing the bul-

bous articular surfaces (cva) for extrinsic contact with similar episternal surfaces on the prothorax (Fig. 35, cva). The posterior cervical rim unites with tergal (T_1), episternal (Eps_1), precoxal (Prcx) and sternal (Stn_1) parts of the prothorax within the anterior hollow receiving the postoccipital elevation (Fig. 20, Poc).

The cervix is pleated and flexible; the condylar surfaces on the postocciput and episterna serve as fulcra and buffers as the water boatman actively bends and rotates the head. The cervical (or juglar: Crampton, 1914) sclerites, hinging the condyles and prothorax in the generalized plan, are not apparent in Corixidae. (Absent also in *Corizus lateralis*: Davis, 1938.) Their absence may be explained by the presence of the lateral postoccipital processes (Figs. 19, 20, pr). These assist in the requisite functions of connection and activation by thrusting into the prothorax and providing attachment for protractor, retractor and rotator muscles. In turn, the derivation of the processes may relate to the absent cervical sclerites.

THE PROTHORAX

The prothoracic segment (Figs. 35-38) is reduced to the essentials of an active, ringlike support for the head and forelegs. This is particularly evident in the nymph (Fig. 8, T_1) lacking the dorsal scooplike extension of the pronotum (Fig. 42, T_1) over the mesothorax. In the adult corixid, the prothorax is capped by the dorsolaterally expanded head, and in turn fits closely over the anterior pterothorax. Since the wing bases conceal the metanotum, the pronotum is the only tergal portion of the thorax largely exposed in the resting position. (When the pronotum tilts forward in action, a posterior triangle of the mesonotum—the scutellum, Fig. 3, Scl_2—is proportionally uncovered. The scutellum is characteristically exposed in the Micronectinae.) The dorsal cephalic portion of the prothorax enters the lateral walls, or pleura, which taper down to a narrow ventral bar, the sternum (Fig. 37, Stn_1), between the legs. The prothoracic segment is slanted in correlation with the opisthognathous head and the angle of the anterior pterothorax.

The Pronotum. The free caudal expansion of the pronotum is cross-striated with varyingly continuous light and dark bands, less definite in *Ramphocorixa* (Fig. 4) where sharply contrasting markings are not characteristic. The expansion is important as an air retainer and a protective shield, but represents only a secondary flap of the primarily important cephalic pronotum (Fig. 42, T_1) concealed by the expanded vertex (Vx). Here the dorsal intersegmental membrane (Isgm) attaches at the base of the pronotal

shield, and the dorsal prothoracic muscles fasten anterior to the membrane.

The exposed pronotal area may have a broadly rounded mesal elevation, with individual variance. The concealed cephalic area is halved by a mesal suture (Fig. 35, ms) with an internal ridge (Fig. 36, mr). The suture is continuous with the epicranial molting line in the nymph; the ridge provides additional surface for muscle attachment.

Pleural Areas. A deep groove (Fig. 38, pla) subdivides each lateral prothoracic wall above the limb base. The pleural apophysis (Fig. 36, PlA) rises from the inner ridge of the groove, arching above the coxal cavity to join a process of the sternal furca (fu). The ridge (plr) forks above the base of the apophysis, and continues below to the coxal articulation (Fig. 37, cx ap). Thus the groove, an inflection contributing to the pleural ridge and apophysis, is part of the pleural suture (Fig. 38, pls), separating the presutural episternum (Eps_1) from the postsutural epimeron (Epm_1) (Snodgrass, 1935). The pleural and the lateral tergal walls are continuous above the pleural sutures.

The episternum (Fig. 35, Eps_1) bounds the lateral rim of the prothoracic opening. The ventral part of the pleurite tapers abruptly into a narrow strip ending in the cervical articulation (cva). The ventral epimeron (Epm_1) forms a lobe (Fig. 37, Epm_1), continuous with the narrow postcoxale (Pcx) behind the coxal cavity. The lobe is separated by an indentation at the coxal articulation from the wide precoxale (Fig. 38, Prcx) which lies before the coxal cavity and below the ventral episternum. The precoxal and postcoxal bridges (Fig. 37, Prcx, Pcx) unite with the sternum (Stn_1).

The Prosternum. The ventral wall of the prothorax is concealed by the overlapping rostrum and the converging basal segments of the forelegs (Fig. 36, Cx, Tr). The sternum is reduced to a narrow sclerite (Fig. 37, Stn_1) between the coxal cavities, joined by the precoxal and postcoxal bridges (Prcx, Pcx). The sternal wall is tilted almost vertical by the extreme slant of the prothorax beneath the anterior pterothorax. A pair of lateral processes, the furca (Figs. 35-38, fu), thrusts up into the pterothoracic opening. Among the muscles attaching on the furca are those connecting it with a similar development of the mesosternum. Within the prothorax the pleural apophysis (Fig. 36, PlA) units with the furca at the junction of the postcoxale (Pcx) and the outer sternal wall, forming the pleurosternal bridge (plst).

THE PTEROTHORAX

The wing-bearing thoracic segments show the expected alterations from the generalized condition in the stream-lining, compactness and specialization of appendages necessary to an underwater swimmer. The pleural chambers in which air may be locked by the wings are special developments of particular interest in the water boatman. The expanded pronotum and the wings largely conceal the broad tergal areas. The mesonotum (Fig. 42, T_2) humps over within the hollow of the prothorax, placing the intersegmental communication in a ventral position. The usual slant of the pleural areas, encroaching on the sternal, is correlatively exaggerated (Figs. 39, 41). In contrast with the extreme slope of the anterior pterothorax, the posterior is almost directly truncate in the broad junction with the abdomen.

Tergal Areas. The base of the intersegmental membrane on the anterior pterothorax is diamond-shaped, enclosing the large opening and a triangular phragma (Fig. 41, 1Ph). Muscles from the anterior (ventral) surface of the phragma attach on the inner pronotal wall and the dorsal postoccipital ridge (Fig. 19, r). Within the pterothorax, dorsal longitudinal muscles connect the much larger posterior phragma (Fig. 42, 2Ph) with the inner surfaces of the anterior phragma (1Ph) and the bulbous dorsal expansion of the anterior mesonotum (T_2). The posterior phragma descends from the antecostal suture (that is, as an extension of the antecosta, or intersegmental inflection), overlapped by a dorsal flange of the postnotum (Fig. 40, Pn_2). The mesonotal dome (T_2) is thus separated from the smaller metanotum (T_3), joined squarely with the first abdominal tergum. At this junction, the expected third phragma is missing from the antecosta (Fig. 42, I Ac). The condition is similar in notonectids.

With the concentration of the corixid locomotor mechanism in the pterothorax, the mesothoracic muscles are largely specialized in arrangement and proportion as wing activators; the metathoracic muscles are chiefly activators of the powerful swimming legs, though also serving the wings in flight. Wing movement (p. 322) depends largely on the flexing of tergal areas, acting on the wing bases (Fig. 39, W_2, W_3) against the pleural wing processes (plw_2, plw_3). In correlation with the main locomotor function shown by the two segments of the pterothorax, the metanotum is the larger in the wingless nymphs, and the mesonotum becomes larger in the winged adults.

In the water bugs examined (*Ranatra, Belostoma, Notonecta, Buenoa* and corixids), a median and two lateral lines of flexure (Fig. 40, ms, no) are well established on the anterior mesonotum. The median suture is also the molting line in the nymphs. The lateral lines probably represent the notaulices, or parapsidal sutures, shown by Malouf (1932) in the stink bug. In the corixid, each notaulix (Fig. 41, no) is intersected by the mesal end of an incomplete transverse suture (ts). The prescutum ($Prsc_2$) is thus imperfectly separated from the scutum (Sct_2). In this connection, it may be reemphasized that the traditional thoracic tergal divisions seem generally more for the sake of reference than morphologically significant (Levereault, 1936). The original dorsal divisions of the mesothorax given by Fieber (reviewed in Hagemann, 1910) were the "dorsulum," covered by the pronotum, and the "scutellum," more or less exposed.

Two additional pairs of flexure lines (Fig. 40, f, rvs) enter the corixid mesonotum. The posterior (rvs)—the clearest and most persistent, occurring also in the notonectids—possibly represents part of the absent scuto-scutellar suture, though more likely an intrascutal reversed notal suture (Snodgrass, 1935). The corixid scutellum (Scl_2) is thus undefined anteriorly, but the posterior margin is always indicated by the inner extension of the axillary cord (Axc_2). This continues inward from the vannal (posterior) margin of the forewing along the deep V-shaped mesonotal groove (WG) which receives the inner postaxial margins of the flexed forewings. By prying up the mesal flange behind the groove (Pn_2), the inflected postnotum, the antecostal suture and the anterior wall of the metanotum are exposed. The flangelike development is the only uncovered part of the postnotum between the line of the axillary cord, or posterior boundary of the scutellum, and the intersegmental line, or antecostal suture.

The posterior phragma (Fig. 43, 2Ph) is an apically divided, anteriorly hollowed plate, braced by the lateral antecostae (Ac) and a contributory mesal inflection of the metanotum (mr). Excepting the suture of this ridge (Fig. 40, ms), the metanotum (T_3) is divided only by the line of the axillary cord (Axc_3), separating the fused scuto-scutellar region ($Sct\text{-}Scl_3$) from the laterally distinct postnotum (Pn_3). The curvature of this boundary closely follows that of the anterior intersegmental line, carrying the base of the hindwing forward. The posterior antecostal suture (Fig. 43, acs), separating the postnotum from the first abdominal tergum (I T), is directly transverse and without a phragma on the antecosta (I Ac).

Pleural Areas. The pterothoracic pleura enter largely into the venter. The areas are primarily distinguished by reference to the pleural suture and its developments. The basic relations of this inflection have been indicated in the relatively simple prothorax (p. 313), there separating the presutural episternum and the postsutural epimeron, from the coxal articulation to the pleural apophysis. The latter joins the sternal apophysis (in the furca), forming the inner pleurosternal bridge (Fig. 37, plst) across the prothoracic coxal cavity bounded by the precoxal and postcoxal bridges (Prcx, Pcx). The pleural and sternal apophyses are not joined in this fashion in the pterothorax, and the circumcoxal bridges are fused into adjacent pleurosternal parts. The basic relationships are complicated by the special features of flight, air chambers and extreme tilting.

The mesothoracic pleural inflection (Figs. 39, 41, pls_2) runs forward on the lateral venter from the coxal articulation (Fig. 43, cx ap_2), curving abruptly upward along the anterior margin of the air chamber (Fig. 39, AC) and into the base of the pleural wing process (plw_2). The inflection is strongest in the upturn, with the stout pleural apophysis (Fig. 43, PlA_2) developed on the inner ridge and connected by short fibers to the attenuated sternal apophysis (that is, the anterior process of the furca, pr'). The mesothoracic episternum (Figs. 39, 41, Eps_2) is the sclerite anterior to the pleural suture. The narrow dorsal extension braces the pleural wing process behind an area variously flexible in the tergal movements activating the forewing. This area is probably derived from the prealar bridge between the prescutum and the episternum, as suggested by Malouf (in the stink bug, 1932). The ventral episternum (Fig. 41) is broad and imperfectly separated from the sternum by differences in surface level and an incomplete suture.

The mesothoracic epimeron (Figs. 39, 41, Epm_2), posterior to the pleural suture, is curiously altered to form the outer wall of an air chamber. The inner wall of this pocket under the forewing margin (Fig. 39, AC) is largely an extension of the lateral dorsum, bearing the spiracle and tympanal organ (Sp_2, Tymp; p. 318), plus an anterior inflection of the metathoracic episternum (Eps_3). These inner parts are overlapped by an epimeral flap (Fieber's "scapula") (Epm_2) with a small hook (h) attaching on an inflected marginal scroll (sl) of the folded forewing. The progressive development of the broad flap from the basically narrow epimeron may be traced in the nymphs.

The metathoracic pleural coxal process (Fig. 43, cx ap_3) is high in the posterior lateral wall, beside the enlarged coxal cavity. The

pleural suture (Fig. 39, pls_3) runs forward from the coxal articulation, diagonally through the length of a shallow extension of the air chamber beneath the forewing margin (AC′). The wing process (plw_3) lies above the anterior end of the pleural inflection, which continues (Fig. 43, plr_3) into the antecosta (Ac) without developing the typical pleural process.

The metathoracic episternum forms the lower wall of the hollow containing the pleural suture, and the posterior inner wall of the larger air chamber (Fig. 39, Eps_3). The broad external plate (Figs. 39, 41) narrows ventrally, with the mesal extremity fitting into the basal constriction of a spearlike sternal development (the metaxyphus, Fig. 41, Sl_3). The anterior ventral margin is overlapped by the mesothoracic epimeron and a flap of the sternum behind the mesocoxal cavity. Where these overlapping elements meet laterad of the cavity, the orifice of the scent gland (sgo)* shows in the intersegmental crevice, or "metacoxal groove."

The metathoracic epimeron (Fig. 39, Epm_3) forms the upper wall of the posterior air chamber (AC′) and continues on the surface beneath the wing into the area posterior to the axillary cord (Axc_3). The dorsal part of this area must represent the postalar bridge from the postnotum (Pn_3) to the epimeron, as suggested by Malouf (in the stink bug, 1932). The posterior part of the area is continuous with an oddly shaped lobe (lbe). In the nymph, this is a simple lateral pouch beside the first abdominal tergum, though deriving also from the epimeral region; the tip of the pouch shelters the spiracle. In the adult, the hollow lobe communicates with the thorax, and is set off from the abdomen by an extension of the antecosta (Fig. 43, I Ac); the spiracle (Fig. 39, I Sp) opens within the membranous corner of the first abdominal tergum (Fig. 51), rounded by the antecostal inflection (acs). While definitely part of the adult thorax, the lobe serves as a supporting pleurosternite of the reduced first abdominal segment, articulating firmly with the tergal margin of the second.

The air chambers (Fig. 39, AC, AC′) are particularly interesting developments of the pleural region, because of the arrangement of contributing parts, as described, and the spiracular and sensory connections. The large metathoracic spiracle (Sp_3) is in direct com-

* Hungerford, in Brindley (1929). Tower (1913) figured the orifice in a similar position in *Anasa tristis*, and Davis (1938) found "a pair of scent gland ostioles in the anterior pleural portions of the metathorax" in *Corizus lateralis*. Brindley described the glands of *Corixa*, with a brief summary of the work on other hemipterans, and a tabulation of the position of the nymphal glands in seventeen species, representing ten families. Variations in nymphal Lygaeidae were given by Usinger (1938). Note also the work of Gulde (1902) and Krüger (1909).

munication with the other two major spiracles (Fig. 43, Sp_2, I Sp) by lateral tracheal trunks. The thoracic spiracles (Sp_2, Sp_3) are simple openings, probably chiefly inspiratory. The first abdominal spiracle (I Sp) opens out through a membranous cone, directed across the hollowed dorsal surface of the lateral lobe (Fig. 39, lbe). This pocket communicates with the space beneath the wings and with the exterior through a crevice between the lateral lobe and the tergal margin of the second abdominal segment beside the metacoxal cavity. The suggestion is that air is drawn through the anterior spiracles into the large thoracic tracheae and exhausted through the posterior spiracle, returning to the constant supply over the body. The circulation is probably aided by the hind limbs sweeping backward over the outer air film. The relation of the movement to the carbon dioxide tension has been discussed by Botjes (1932).†

The curious tympanal organ in association with the metathoracic spiracle (Fig. 39, Tymp) consists of a free, club-shaped portion arising from a heavy base resting on an oval membrane. The organ was studied by Hagemann (1910; quoted in Imms, 1925; Weber, 1930; and Beier, 1938). The freely moving club, the basal membrane and the nerve connections suggest the sensory functions of hearing and equilibration.

Sternal Areas. The true sternal parts on the broad under surface (Fig. 41, Stn_2, Stn_3) are reduced to comparatively limited median areas by the encroaching pleural plates (Eps_2, Epm_2, Eps_3). The reduction of the sterna is accompanied, or made possible, by the transference of muscle attachments to the large furcae (Fig. 43, fu_2, fu_3).

The mesothoracic sternum (Fig. 41, Stn_2) is fused with the opening into the pterothorax. This basal rim is thickened in contact with the sternal region of the active prothorax. The mesosternum is divided by a median (mfus) and two lateral inflections (sacs). The latter form the transverse sternacostal suture, setting off the narrow sternellum (Sl_2) from the basisternum (Bs_2). The inflections extend into the furca (Fig. 43, fu_2), the anterior median ridge (mfur) brac-

† Dr. H. B. Hungerford has pointed out that "kneading" the air bubbles may be of importance in respiration. Comstock (Hyatt and Arms, 1890) described *Coriza* as having "its body almost completely enveloped with air, which glistens like silver. This air-film is constantly retained, and probably acts as a tracheal gill, so that the insect is able to remain under water a long time." Kirkaldy (1905) and others have noted the ability of corixids to remain under the surface in pure water for indefinitely protracted periods. Doctor Hungerford reports specimens from depths making frequent tips to the surface impossible. The respiration habits of corixids have been treated by Lamarck (1835), Régimbart (1875), Packard (1877), Brocher (1909), Hagemann (1910), Bueno (1916), Rousseau (1921), Taschenburg (1929), et al. The works of Brocher, Hagemann, Rousseau, and Botjes (1932) are particularly recommended.

ing the posterior transverse plates, or sternal apophyses (which fuse to form the furca). Above the median brace, the furca divides; each fork subdivides into a stout posteromesal prong (pr) and an attenuated anterolateral process (pr′), both flaring at the apex for muscle attachments. Among the muscles attaching on the posterior projection are those reaching the prothoracic and metathoracic furcae and the posterior phragma; the anterior process (pr′) connects by short fibers with the mesothoracic pleural apophysis (PlA_2). The precoxal bridge between the episternum and the sternum is not developed separately; the postcoxal bridge from the epimeron probably enters into the anterior margin of the broad plate behind the mesocoxal cavity.

The metathoracic sternum shows behind the contiguous middle coxae in a projection shaped like a spearhead (Sl_3). This is the sternellum (the metaxyphus of taxonomists), set off from the concealed basisternum (Bs_3) by the basal position of the sternal apophyses (sa). The sternellum continues laterally in a flange along the anteroventral margin of the episternum (Eps_3) to the orifice of the scent gland (sgo). The basisternum is concave on either side behind the bulbous mesocoxae. The large metathoracic furca (Fig. 43, Fu_3) rises on two stout pedestals, joining above the hollowed inner sternal surface and forking immediately to form a cradle-like structure which supports the central nerve cords and attachments of important thoracic and abdominal muscles.

THE THORACIC APPENDAGES

The Legs. The example of advanced specialization shown by the corixid legs could scarcely be improved. These instruments of food gathering, anchorage and swimming are arranged along the thorax like the neatly racked tools of any precise workman, exactly fitting their several purposes and in proper position for instant service. The *adaptive* character of the specialization is most interesting. The strikingly different three pairs of legs are basically similar in structural plan, attachment and flexure; the adaptations have been effected largely through *proportional* changes in the typical segmentation (cf. Figs. 45, 47, 48): coxa (Cx), trochanter (Tr), femur (Fm), tibia (Tb), tarsus (Tar) and pretarsus (Ptar).

In each leg, the proximal rim of the coxa, or basicoxite (Bcx), slants from the mesal surface to the lateral, there produced (ap) to articulate with the ventral knob of the pleural ridge (the pleural coxal articulation previously discussed). The proximal attachment is completed by the flexible membrane, or coxal corium, joined to

the pleural and sternal walls within the coxal cavity. The reduced trochantin (Fig. 47, Tn) in the membrane attaches ventrally on the basicoxite. The converging coxae are nearly horizontal and thus overlapped by the anterior margins of the coxal cavities. The monocondylic pleurocoxal joint permits rotation and lateral movements, limited by the circumcoxal boundaries. The remaining joints of the limb segments are dicondylic, the greatest flexion occurring on the coxotrochanteral and femorotibial axes. In the middle and hind legs, extended backward against the venter, these axes are nearly vertical, as are the tibiotarsal and tarsopretarsal axes. In the forelegs in a similar position, the distal axes are altered to nearly horizontal by a torsion of the oblique trochanterofemoral axis from horizontal to nearly vertical, tending to crook the palae (foretarsi) forward beneath the rostrum.

The stout prothoracic legs (Fig. 44-46) are perfectly adapted for gathering the peculiar dietary requirements of the water boatman. The tarsi, or palae (Tar), are given emphasis in this function and are proportionally enlarged. The tarsus, femur and coxa are the longer segments of the foreleg; the short tibia and the trochanter are nearly equal. The cylindrical coxa bears a conspicuous round pit, possibly sensory, on the upper lateral surface (Fig. 44, p). The pretarsus is represented only by the curved apical claw, provided with tendon and flexor muscle and serving as an active raptorial element in the setal basket on the tarsus.

In position beneath the rostrum, the spoonlike female palae are triangular in section with the thickened anterior surface tapering to the posterior margin. The curved upper surface, passed under the ridged face of the rostrum in feeding, is finely spined and bordered with setae; a few slender spines are set along the under surface. The posterior marginal setae and a row on the anterior surface are especially long, completing the basket and sifter of an efficient tarsal instrument for digging and sorting the food organisms from ooze.

The specific variance in shape of the male palae (Fig. 46, Tar) is of taxonomic importance. The row of pegs (pg) on the upper anterior area has been considered of use in chirping, the sound supposedly produced by the pegs grating on the furrowed rostrum (Ball, 1845; Landois, 1874; Schmidt, 1891; Handlirsch, 1900; Howard, 1905; Maxwell-Lefroy, 1923; Lenz, 1928; Taschenberg, 1929; et al.). Handlirsch (1900) also suggested that the males might chirp with the strigil (on the abdomen, q. v.), and this was in part supported by Carpenter (1924). Kirkaldy (1901) assigned the stridulation

of corixids to the action of the tarsal "comb" against the "stridulatory area" on the inner surface of the opposite femur, though admitting it must need "very considerable gymnastic efforts." (cf. Hutchinson, 1929.) It has been established, however, that chirping results from the friction of the stridular patch on the femur (Fig. 46, str) across the thin lateral margins of the head. This was suggested by Carpenter (1894), by Hagemann (1910), and confirmed by Mitis (1935), who described the scraping of the "chirping field" over the sharp cephalic margin between the antenna and the rostrum. Air chambers of the head and prothorax were said to add resonance.

The mesothoracic legs are greatly elongated (Fig. 47), acting together from the contiguous bulbous coxae as a pair of tongs, striking deep anchorage for the buoyant corixid in the ooze where it feeds. The long segments taper evenly, with progressive reduction, from the oblique union with the short trochanter to the pretarsus, here represented by a pair of slender claws. These claws are operated by a single flexor tendon, as in the foreleg. The distal limb segments are lined with spines and setae, particularly dense on the tibia and tarsus. The leg is never completely straightened on the femorotibial joint; a slight twist on the oblique trochanterofemoral axis aids the coxa in turning the apical segments back, trailing loosely under the venter in swimming, and the reverse movement brings the claws in direct opposition in the anchoring position.

The metathoracic legs are large, efficient swimming limbs (Fig. 48), in their action combining locomotive power with the niceties of "feathering" necessary in the use of oars under water. The helmet-shaped coxa and the activating muscles are far superior to the comparable mechanism in the anterior and middle legs. The pleural coxal articulation is extremely lateral, and the most important metathoracic muscles enter the limb through the large coxal cavity. The driving stroke is made with the "oar" extended from the coxotrochanteral axis near the center of the body. This position plainly contributes to rapid maneuverability. The elongated, flattened tarsus is the blade of the oar, with the pretarsus forming the apex. The long segments are lined with spines and setae, as in the middle leg, arranged on the tibia and, particularly, on the tarsus in posteriorly directed fringes, adding to the effectiveness of the paddle. Flexure on the oblique trochanterofemoral axis rotates the length of the limb, presenting the face of the blade on the stroke and its edge on the return.

The Wings. Water insects in flight seem to represent an organ-

ismic ideal of the flying submarine, the Corixidae no less than others. The wings of such insects must be capable of assuming with equal speed and efficiency the *aquatic* or the *aërial* position in the swift change of environment. In the water, the gauzy hind wings of the corixid are folded neatly under the shielding forewings, which are tightly fitted in the flexed position, contributing largely to the requisite trimness of the smooth back. In the air, the wings are extended to whirring activity and that remarkable proficiency in flight shown by many insects molded as distinctly, almost perfectly, for life under water.

As usual in Hemiptera, the corixid forewing ("hemelytron" or "tegmen") is heavier basally, with a distal membrane (Fig. 49, Mb). The basal portion is divided diagonally (vf) into the inner, or posterior, "clavus" (Cl) and the outer, or anterior, "corium" (Cm) (Comstock, 1918)—morphologically the vannus (Vs) and the remigium (Rm) (Snodgrass, 1935), as shown on the hind wing (Fig. 50). Sealing over the folded posterior wings, the vannal regions of the flexed anterior wings join tightly along the middle length of the body (Fig. 3) and the slanting inner proximal margins, varyingly overlapped by the pronotum, fit into the deep V-furrow on the mesothorax. (Fig. 40, WG.) The outer areas of the flexed forewings also turn down—the eaves of the roof over the abdomen. The right "membrane" (Fig. 49, Mb) is almost as heavily sclerotized as the basal areas, and regularly covers the left, which is often marginally lighter (particularly in *Ramphocorixa acuminata*). The distal array of veins commonly found in terrestrial Hemiptera is missing; most of the wing venation is concentrated in simple basal girders. Corixids are usually tigroid in appearance, with stripes on the pronotal shield and sinuous transverse mottlings on the forewings. These markings are less distinct in *Ramphocorixa*.

In the flexed hindwing, the vannus bends under the remigium along the vannal fold (Fig. 50, vf), with accessory pleating in both wing regions. Either wing may lie over the other, though the right usually overlaps the left. The fanlike, diaphanous membrane is strengthened in the anterior remigium and middle vannus by veins with enough pigmentation and relief to show plainly. The veins in the posterior remigium are less easily traced.

When extended, both wings show an arrangement of tiny articular sclerites, more or less fused, at the humeral angle (Figs. 49, 50, aAx, 3Ax). These essential parts of the wing base mechanism are important in establishing the wing vein homologies (Snodgrass, 1935;

Levereault, 1936). The relations are shown best on the ventral side of the wing bases, with the plane of each wing fully extended upward (Fig. 39). In both wings (W_2, W_3), the costal margin rotates outward as the plane of the wing turns forward and up in the movement of extension. The fulcrum for all wing movement is the pleural wing process (plw_2, plw_3), articulating with the fused anterior axillary (aAx_2, aAx_3). This axillary is evidently a composite of the humeral (costal) plate, the first (subcostal) and the second (radial) axillaries, the latter resting typically on the pleural process.

The third (vannal) axillary in the forewing ($3Ax_2$) is represented by a flexible chain of four pieces next the basal vannus and the axillary cord (Axc_2). The tiny sclerotized parts assume relations in the extended wing which help lock the base in the flight position. Flexion begins with the contraction of the strong muscle reaching from the pleural ridge to the proximal part of the chain, tripping the mechanism. In the hindwing, the third axillary is represented by two hinged bars ($3Ax_3$), the proximal receiving the flexor muscle from the pleural ridge. This muscle is proportionally weaker than its homolog in the forewing which is the greater force in initiating the flexion of both wings. The action is controlled by relaxation of the powerful thoracic muscles responsible for wing extension and flight movements through flexure of the adjacent tergal areas. Wing flexion is completed by retraction of the pronotum over the wing bases.

The basal sclerotic fields in the hind wing (Fig. 50, Mp, Mp′), articulating with the anterior and third axillaries, represent the divided median plate (medial axillary). These fields are less easily defined in the general sclerotization of the forewing, but are probably the basal scroll-like development, attached to the anterior axillary, and the adjacent triangular area (Fig. 49, Mp, Mp′). The posterior wing shows best the established relations of axillary sclerites and wing veins, used here in determining the homologies of corixid wing venation and generally indicated by the parenthetical terminology given each axillary above (cf. Levereault, 1936).

In the hind wing (Fig. 50), costa (C), subcosta (Sc), and radius (R) are fused in a marginal girder articulating with the anterior axillary (aAx_3). The extension of the radius into R_1 and the radial sector (Rs) is similar to the branching in Notonectidae (Hutchinson, 1929). The radial sector is apically forked (R_{2+3}, R_{4+5}). Media (M) and cubitus (Cu) are based on the median plates (Mp, Mp′). The anterior branch of media (M_{1+2}) fuses with the radial sector

and the free posterior branch (M_{3+4}) runs through a large pleat of the wing. The medial (m) and mediocubital (m-cu) cross-veins are broken at the edges of the pleat. Cubitus branches at the base (Cu_1, C_2); the anterior vein is forked (Cu_{1a}, Cu_{1b}), meeting the tip of Cu_2. The strong vannal vein (V) articulates with the third axillary (3Ax), bracing the postaxial plane of the wing.

In the forewing (Fig. 49), costa, subcosta and radius (C+Sc+R) are fused in the thickened costal margin, extending from the anterior axillary (aAx_2) and intersected by the "nodal furrow" (nf). Media (M) and cubitus (Cu) arise from the median plate—the former from the proximal scroll-like piece (Mp), the latter from the distal triangular area (Mp')—and meet at the "nodal furrow." Continuing from this point, the fused veins are apparently joined by the down-curving distal part of radius (R+M+Cu). The strong vannal vein (V) converges on the vannal fold (vf) from the basal vannus, which articulates with the third axillary (3Ax) and is crossed by the marginal line reached by the overlapping pronotum (ml). In both wings the jugal region is suppressed, appearing at most as an inner postaxial pleat of the hind wing.

The Abdominal Skeleton

Compared with the head or the thorax, the abdomen seems relatively unspecialized. Form and function in this important body region fit easily into the aquatic environment without extensive alteration from the generalized plan. The corixid abdomen is the longest and widest region of the body, though its bulk is reduced by flattening and tapering, completing the typical reversed boat shape (Figs. 4, 9, 51). The proportions of the abdomen are incidental to its importance in housing the principal organs of nutrition, excretion and reproduction, with the associated major circulatory, respiratory and neural channels. The segments of the abdomen are most conveniently discussed as *visceral,* or pregenital, and *genital*—the former containing the mass of the organs suggested, and the latter altered to form the accessory instruments of reproduction (Snodgrass, 1935; Levereault, 1936; Larsen, 1938). Generally speaking, segments I-VII compose the visceral region, segments VIII and IX the genital; though the curious sexual dimorphism also involves the male segments IV-VII in the latter. The postgenital region is simplified and unsclerotized in Corixidae.

THE VISCERAL REGION

The Primary Segments (I-III). The metathoracic postnotum (Fig. 40, Pn_3), set off by the axillary cord (Axc_3), represents the

acrotergite of the first abdominal antecosta (Snodgrass, 1935). The sclerites of the first segment posterior to this inflection are reduced in Corixidae to the median sternal prong (Fig. 56, I Stn) uniting with the metathoracic furcasternum, and the bilobed tergite (Fig. 51, I T). The latter thrusts forward in a shelf over the membranous connection with the antecosta; the flexible unsclerotized fore-portion of the first tergum becomes the functional dorsal intersegmental membrane. In each lateral corner, bounded by the thoracic lobe, is the large first abdominal spiracle (I Sp). The membrane continues posterior to the spiracle, deeply notching the second tergal plate (II T) which is firmly joined to the first. The second and third terga (III T) are flexibly united in secondary segmentation as described below.

Union with the thorax is completed by the lateral articulation of the second abdominal segment with the thoracic lobes beside the first segment. The second sternal antecosta is bilobed (Fig. 43, II Ac'), and continues laterally into strong anterior processes (II pr). The large muscles attached (on the median lobes from the metathoracic furca and the anterior third sternal area, on the lateral processes from the first tergite) serve in the action of the abdomen on the mesal and lateral articulations with the thorax. The ventral wall of the second segment (Fig. 56, Ltg, II Stn) forms the posterior margins of the metacoxal cavities (cf. Brindley, 1938), and is concave laterally above the coxae. The spiracles are in these lateral hollows near the bases of the antecostal processes (II Sp). The ventral third segment is divided by a semicircular inflection into anterior and posterior areas (Figs. 42, 43, 56, III Stn_1, III Stn_2), the former also concave above the converging metathoracic coxae. The spiracles are in the lateral posterior areas (III Sp), nearer the margins and smaller than the preceding pair. All of the ventral abdominal spiracles have an inner valvular cone, seemingly an exhaust mechanism like that in the dorsal first pair (p. 318), though reduced and withdrawn.

With the special features indicated, the primary abdominal segments, when complete (second and third), show the typical compressed ring form (Fig. 54) found in the remainder of the visceral region, though with greater median bulk.

Sexual dimorphism (IV-VII). The general segmentation in the female corixid abdomen (Fig. 51) forms a regular series of sclerotic annuli (Fig. 54). The broad tergal and sternal plates (T, Pl-Stn) continue laterally into blade-thin areas (Ltg), tilted up in wide dorsolateral rims with strong setae on the sharp margins. The dor-

sal plates are flexibly subdivided laterally, setting off the laterotergites (Ltg); but the true tergopleural lines are ventral, as shown by the position of the spiracles (Sp), always dorsad to the pleura. The median ventral plates, fused with the lateral, are thus pleurosternal (Pl-Stn), or laterosternal, morphologically.

The laterotergites occupy progressively more of the marginal areas, each hooking backward over the curved anterior corner of the succeeding segment. The small spiracles (Fig. 56, IV-VII Sp) are close upon the faint tergopleural line. The hairy investiture, exposed on the ventral plates and the apical dorsum, is much denser than that on the covered tergal areas. Vestiges of the dorsal nymphal glands are sometimes evident on, or near, the mesal posterior margins of the fourth and fifth tergal plates in both sexes (Figs. 51, 55, gl).

The sagittal section (Fig. 42) shows typical secondary segmentation, with the functional intersegmental membranes (Isgm) removed forward from the antecostae (Ac), or primary intersegmental inflections, and overlapped by the posterior tergal and sternal margins. The median bulk of the abdomen decreases evenly toward the apex. The median caudal margin of the ventral seventh segment thrusts over the eighth, forming the so-called subgenital plate (Fig. 52, sgpl).

In the male corixid abdomen (Figs. 55, 56), segments IV-VII are warped in the asymmetry (Hagemann, 1910) peculiar to the several genera—in taxonomy, "dextral" in *Arctocorixa, Corisella* and *Ramphocorixa*, "sinistral" in *Trichocorixa*—though individual cases of reversal have been noted (Hungerford, 1928). The asymmetry results from the subdividing of the posterior tergal and sternal plates by secondary lines of flexure, and the shortening of one side of the segments involved, accompanied by irregular lobular developments. The complicated, flexible pattern assists the coupling of the sexes, with the male on top and the tip of the abdomen curving down and around one side, according to the nature of the asymmetry. Larsen (1938) has described in an extensive work the structure and function of the pregenital and genital regions of *Corixa dentipes* and *Sigara sahlbergi*, the former with sinistral, the latter with dextral asymmetry. The irregular skeletal developments are specifically variable; *Ramphocorixa acuminata* will be described and figured as a typical example.

The spiracles in the male have the same position as in the female abdomen; the laterotergites are similarly developed, though the

tergopleural lines are not evident. Changes in the median tergal and sternal areas are largely responsible for the male asymmetry. The fourth tergum (Fig. 55, IV T) is posteriorly bilobed, the right lobe larger and both lined with long setae. These lobes are weakly duplicated on the sternum (Fig. 56, IV Stn), and the diagonal cast thus given the undulating posterior dorsal and ventral margins of the fourth segment is continued by those following.

The fifth and sixth terga (Fig. 55, V, VI T) are lobate on the right, and detached posteriorly from the laterotergites on that side. The sterna (Fig. 56, V, VI Stn) are divided on the right by the slanting lines of flexure—angling inward on V, outward on VI—and deep posterior marginal notches. This flexible arrangement is reflected on the terga by a less distinct line of flexure on the fifth lobe and a shallow excavation on the sixth. The latter bears the tiny strigil (Fig. 55, stgl) on a process of the posterior margin. This curious structure resembles a comb lying flat with the teeth inward; though suspected of a part in stridulation in some Corixidae, its true service is in gripping against the female venter in copulation (Larsen, 1938). The stout setae on the posterior margin of the fifth tergal lobe are called the prestrigil by Larsen, who described their action in fastening on the margin of the female forewing. The IV-V and V-VI intersegmental membranes are extended, particularly on the right, permitting the segments to twist to the left side and under the female.

The seventh tergum (Fig. 55, VII T) is deeply notched on the left, with a mesal terminal lobe; the sternum (Fig. 56, VII Stn) has the same general condition, but with the notch and line of flexure on the right, continued from the preceding sterna, as described (V, VI Stn). The extension of the VI-VII intersegmental membrane is particularly evident on the left, permitting the abdominal apex to turn back under the venter of the female.

THE GENITAL REGION

Male. The eighth segment of the male corixid is terminal and divided into asymmetrical halves, each bearing long, apical setae and the tiny ventral spiracle. An inner lobe of the left tergite (Fig. 55, VIII T) encroaches on the right which is correlatively reduced. The condition is reversed by the sternal plates, the right (Fig. 56, VIII Stn) being the larger. This effects a torsion in the chamber formed by the halves of the segment, containing the male copulatory organ. The latter consists of the intromittent phallus based in the capsulate ninth segment (Figs. 57, 58). The segment lies on its right side,

swinging out to the right for union with the female. The extreme curvature of the phallus turns it forward into the vagina when the apical male abdomen is lowered under the female venter.

The ninth tergum (Figs. 57, 58, IX T) is represented by the narrow posterior band on the right. The disproportional sternum (IX Stn) is like a lopsided basket attached to the tergal "handle." The ventral wall is the larger; the left (true ventral) side extends posteriorly in a stout forked process (pr), grooved on the inner side to guide the phallus. Two flattened appendages, irregularly falciform (vhrp, dhrp), articulate on the posterior rim of the ninth segment. These are the lateral harpagones (parameres of Singh-Pruthi, 1925, et al.; genitalhaken of Larsen, 1938; also gonapophyses, claspers or styles of taxonomists), twisted with the segment to dorsal and ventral positions. The dorsal, or left, harpago (dhrp) is heavier and with a larger apodeme for muscle attachment; the grooved inner surface, with an encircling extension near the base (x), assists the posterior sternal process in guiding the phallic shaft.

The corixid phallus is a complex and curious organ. The curved, flexible copulatory shaft arises from the stout phallobase (Fig. 57, Phb) which articulates on the bases of the harpagones. As the phallobase turns on its dorsoventral axis, the long phallus thrusts out between the clasping dorsal harpago and the sternal process. The intromittent organ is remarkably curved, suggesting an interrogation mark in ventral view. Its parts are the outer phallotheca (Thc; the phallosoma of Singh-Pruthi and Larsen); its inner wall, or endotheca (Singh-Pruthi's conjunctiva of the endosoma, Larsen's schwellkörper); and the enclosed needle-like aedeagus (Aed; Singh-Pruthi's vesica of the endosoma, Larsen's flagellum). The basic relations identifying these parts are diagrammed by Snodgrass (1935). The partially sclerotized phallotheca returns elastically to the looped position on relaxation of extrusive pressure. The tip flares into lateral processes, and is not quite reached by the membranous endotheca which opens on the side. The slender aedeagus enclosed by the phallothecal walls extends beyond the opening to the spreading apex of the phallotheca. The hollow needle of the aedeagus joins directly on the ejaculatory duct in the phallobase, and must serve to direct the passage of sperm within the vagina.

The proctiger (Fig. 57, Ptgr) extends as a membranous tube from the tergal region of the ninth segment, directed to the right of the phallic and paraphallic structures. The anus (an) is apical in the membrane. The proctiger comprises the simplified postgenital region in Hemiptera (Snodgrass, 1935).

Female. The eighth segment of the female corixid abdomen resembles that of the male, but the division into lateral halves is symmetrical. The tergum (Fig. 51, VIII T) consists of the divided dorsal lobes, meeting on the mesal line, and the laterotergites which bear the ventral spiracles. The median part of the sternum (Fig. 53) is separate and enclosed by the lateral lobes of the eighth segment (Fig. 52, VIII) and the subgenital plate (Sgpl) (Larsen, 1938). The apex and margins are sclerotized, the median base membranous. The basal apodemes (Fig. 53, pr) receive extrusive muscles from the lateral lobes. When these lobes are spread in oviposition (p. 297), the valvulae of the ovipositor (Larsen's gonapophyses) are exposed. The first pair (1 Vl) are apical on the eighth sternal plate, each tipped with a fingerlike process and a flexible stylus (sty; Crampton's gynostyle, 1929a). The second valvulae (2 Vl) are flattened just above the first, arising from the ventral ninth segment. The two pairs of spiny-tipped valves enclose the large vaginal orifice (vulva). The ninth tergum (Fig. 51, IX T) is best developed apically and laterally, forming a tiny sclerotic crescent; the proctiger (Ptgr) is also sclerotized dorsally. Both pieces are exposed by the gaping tergal lobes of the eighth segment.

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LIST OF ABBREVIATIONS

The abbreviations are alphabetized for *head, thorax, legs, wings* and *abdomen*. Those which refer to orientation, inflections and processes will be found clarified in the discussion of the structure figured.

HEAD

Ant, antenna
As, antennal socket
at, attachment of labial shaft
Br, brain
br, bar
ca, cranial articulation
cgo, cephalic gland orifice
clbcy, contractor of labial cylinder
Clp, clypeus
cs, coronal suture
cva, cervical articulation
d, dorsal
dct, salivary duct
dlbc, dilator of buccal region
dlbo, dilator of labial orifice
dlcb, dilator of cibarial region
dlphy, dilator of pharyngeal region
dlpphy, dilator of postpharyngeal region
dlsyr, dilator of syringe
E, compound eye
Es, esophagus
Fl, flagellum
For, occipital foramen
Fr, frons
FrGng, frontal ganglion
g, groove
Ge, gena
h, hinge
Hos, hypocular strut
hos, hypocular suture
Hphy, hypopharynx
l, lateral
Lb, labium
Lbcy, labial cylinder
lbo, labial orifice
Lbs, labial shaft
Lm, labrum
m, mesal
Mcl, muscle
mda, mandibular articulation
mdl, mandibular lever
Mdpl, mandibular plate
MdS, mandibular stylet
Mr, masticator
Mth, mouth
Mxpl, maxillary plate
MxS, maxillary stylet
o, ocellus (or vestige)
Oc, occiput
pcs, paraclypeal suture
Pdc, pedicel
pfs, postfrontal suture
Phy, pharynx
pmd, protractor of mandible
Pmp, sucking pump
pmx, protractor of maxilla
Poc, postocciput
Pphy, postpharynx
pr, process
PrClp, paraclypeus
r, ridge
rmd, retractor of mandible
rmx, retractor of maxilla
Ro, rostrum
Scp, scape
sm, salivary meatus
Soc, subocciput
Syr, salivary syringe
Vx, vertex

THORAX

AC, air chamber
Ac, antecosta
acs, antecostal suture
Axc, axillary cord
Bs, basisternum
cva, cervical articulation
Cvx, cervix
cxap, coxal articulation process
Epm, epimeron
Eps, episternum
f, furrow
fu, furca
h, hook
Isgm, intersegmental membrane
lbe, lobe
mfur, median furcal ridge
mfus, median furcal suture
mr, median ridge
ms, median suture
no, notaulix
Pcx, postcoxale
Ph, phragma
PlA, pleural apophysis
pla, pleural apophysial pit
plr, pleural ridge
pls, pleural suture
plst, pleurosternal bridge
plw, pleural wing process
Pn, postnotum
pr, process
Prcx, precoxale
Prsc, prescutum
rvs, reversed notal suture
sa, sternal apophysial pit
sacs, sternacostal suture
Scl, scutellum
Sct, scutum
sgo, scent gland orifice
Sl, sternellum
sl, scroll
Sp, spiracle
Stn, sternum
T, tergum
ts, transverse suture
Tymp, tympanal organ
W, wing
WG, wing groove
1, 2, 3, pro-, meso-, metathoracic

LEGS

ap, articular process
bcs, basicostal suture
Bcx, basicoxite
Cx, coxa
Fm, femur
p, pit
pg, pegs
Ptar, pretarsus
str, stridular area
Tar, tarsus
Tb, tibia
Tn, trochantin
Tr, trochanter

WINGS

aAx, anterior axillary
3Ax, third axillary
Axc, axillary cord
C, costa
Cl, clavus
Cm, corium
Cu, cubitus
M, media
m, median cross-vein
Mb, membrane
m-cu, mediocubital cross-vein
ml, marginal line
Mp, median plate
nf, nodal furrow
R, radius
Rm, remigium
Rs, radial sector
Sc, subcosta
V, vannal vein
vf, vannal fold
Vs, vannus
2, 3, meso-, metathoracic

ABDOMEN

Ac, antecosta
acs, antecostal suture
Aed, aedeagus
an, anus
dhrp, dorsal (left) harpago
gl, gland (or vestige)
Isgm, intersegmental membrane
Ltg, laterotergite
ms, median suture
Phb, phallobase
Pl-Stn, pleurosternum
pr, process
Ptgr, proctiger
Sgpl, subgenital plate
Sp, spiracle
stgl, strigil
Stn, sternum
sty, stylus
T, tergum
Thc, phallotheca
vhrp, ventral (right) harpago
Vl, valvifer
x, extension
I-IX, 1st to 9th abdominal

PLATES

The figures, unless otherwise indicated, represent structural studies of *Ramphocorixa acuminata* (Uhler). The gross regional views were drawn using an ocular micrometer at 42.5x. Detailed studies were made with higher magnification, using a camera lucida for the sagittal sections and the wings. The figures are intended as studies in proportion and relationships; the surface ornamentation has been sparsely indicated.

PLATE XVI

FIG. 1. Lateral view of egg.
FIG. 2. Eggs on *Cambarus simulans* Faxon.
FIG. 3. Dorsal view of male.
FIG. 4. Dorsal view of female.

PLATE XVI

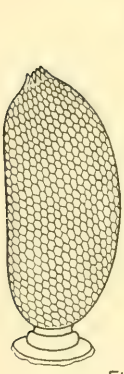

FIG. 1

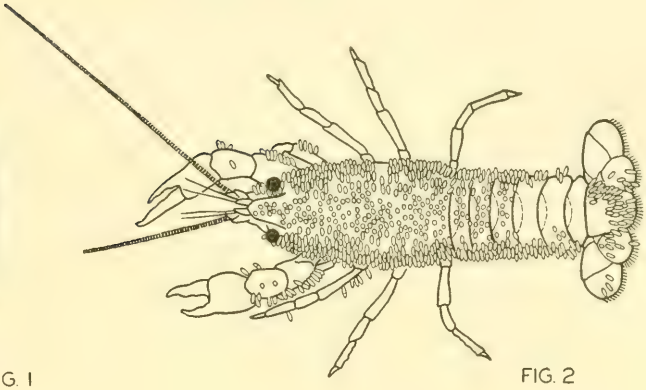

FIG. 2

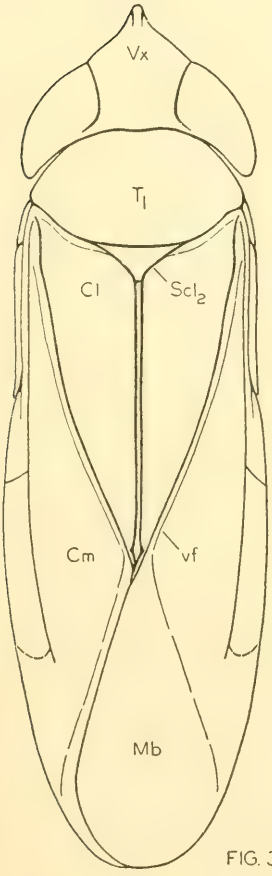

FIG. 3

FIG. 4

PLATE XVII

FIG. 5. Dorsal view of first instar.
FIG. 6. Dorsal view of second instar.
FIG. 7. Dorsal view of third instar.
FIG. 8. Dorsal view of fourth instar.
FIG. 9. Dorsal view of fifth instar showing color pattern.
FIG. 10. Vertex of *Diaprepocoris barycephala* Kirk.
FIG. 11. Lateral view of egg drawn in proportion to Figs. 3-9.

PLATE XVII

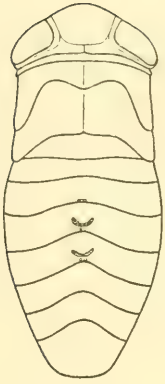

FIG. 7

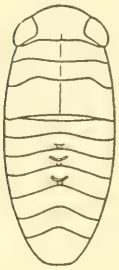

FIG. 6

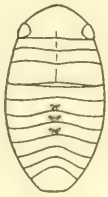

FIG. 5

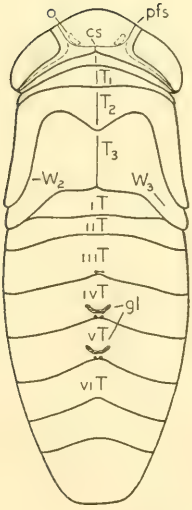

FIG. 8

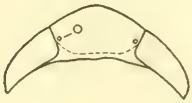

FIG. 10

FIG. 11

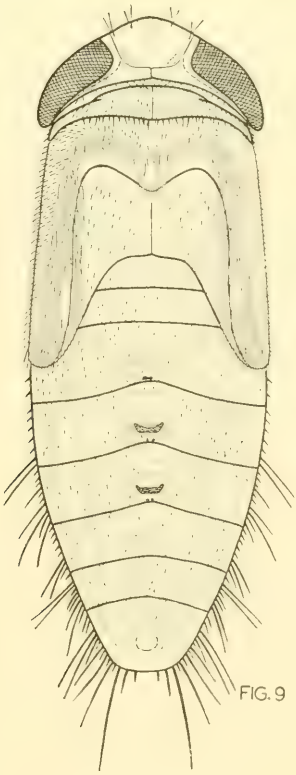

FIG. 9

PLATE XVIII

FIG. 12. Apical view of hatching egg. d = dorsal.
FIG. 13. Lateral view of hatching egg.
FIG. 14. Apical view of hatching egg.
FIG. 15. Remnants of digested algae found in dissection.
FIG. 16. Remnants of digested rotifers found in dissection.

PLATE XVIII

FIG 12

FIG 13

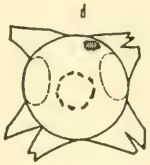

FIG. 14

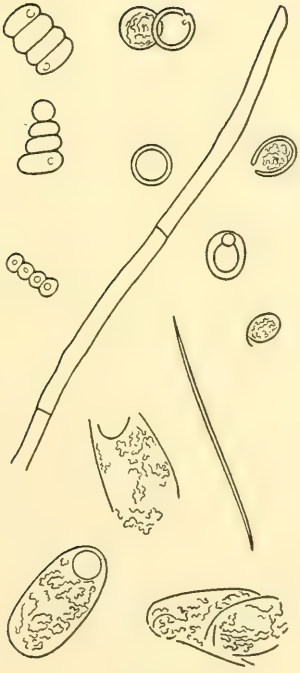

FIG. 15

FIG. 16

PLATE XIX

FIG. 17. Lateral view of male head.
FIG. 18. Anterior view of male head.
FIG. 19. Posterior view of female head.
FIG. 20. Lateral view of female head.
FIG. 21. Anterior view of female head.

PLATE XIX

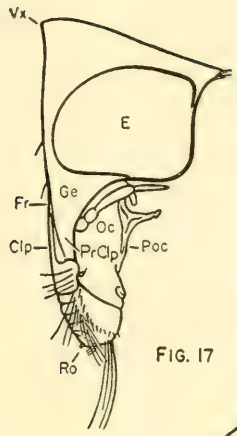

FIG. 17

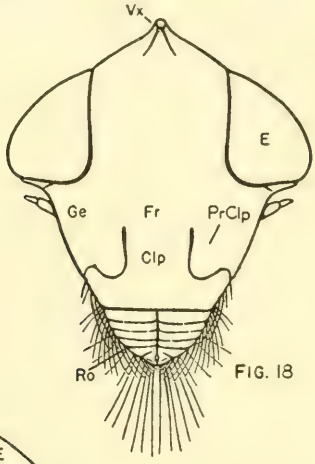

FIG. 18

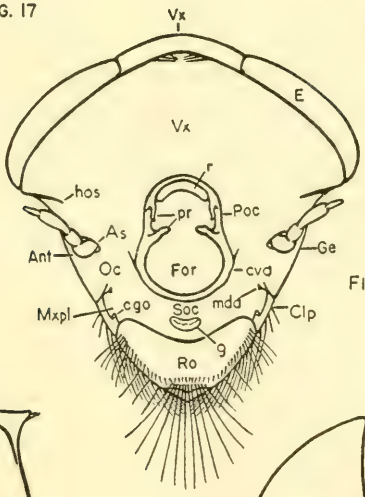

FIG. 19

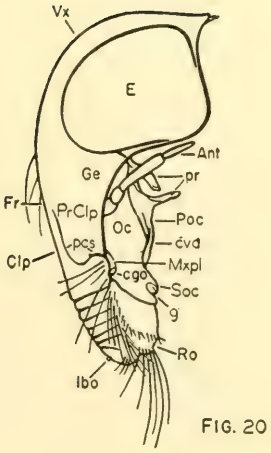

FIG. 20

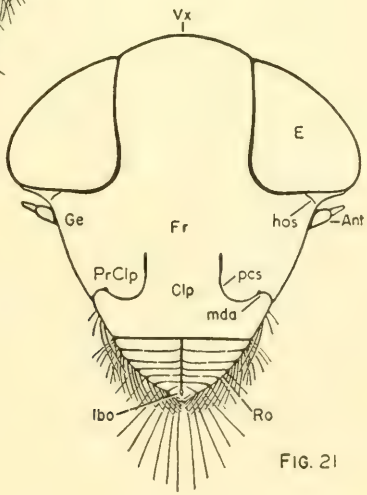

FIG. 21

PLATE XX

FIG. 22. Median sagittal section of head (*Arctocorixa sp.*).

FIG. 23. Median sagittal section of head (*Notonecta sp.*).

FIG. 24. Lateral view of cranial apex after removal of rostrum.

FIG. 25. Anterior view of structures within cranial apex after removal of rostrum. Margin of clypeus indicated by broken line.

FIG. 26. Posterior view of antenna and hypocular strut.

PLATE XX

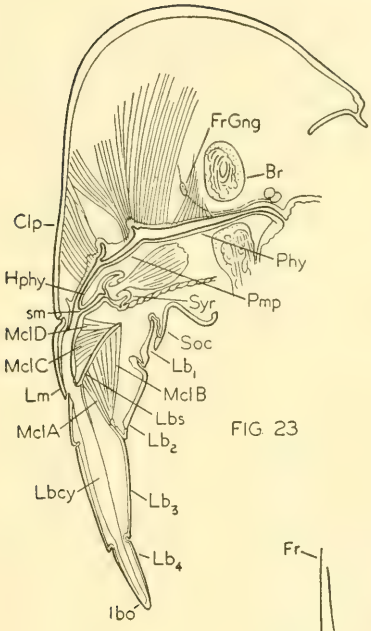

FIG. 23

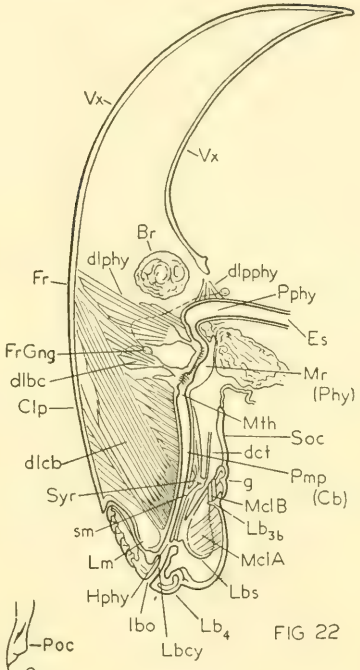

FIG 22

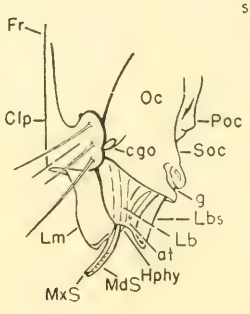

FIG. 24

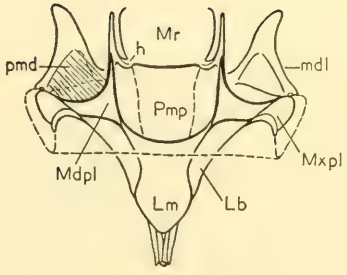

FIG. 25

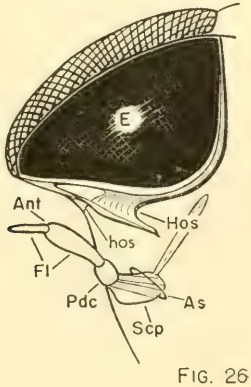

FIG. 26

PLATE XXI

FIG. 27. Anterior view of right mandibular stylet.
FIG. 28. Posterior view of right mandibular stylet.
FIG. 29. Posterior view of ingestive structures within cranial apex.
FIG. 30. Anteromesal view of right maxillary stylet.
FIG. 31. Anteromesal view of left maxillary stylet.
FIG. 32. Anteromesal view of apex of left maxillary stylet.
FIG. 33. Dorsal view into rostrum.
FIG. 34. Anterior view of rostrum.

PLATE XXI

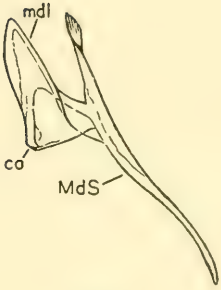

FIG 27

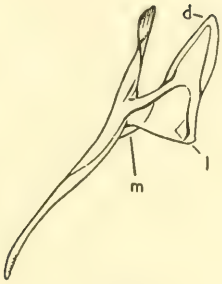

FIG. 28

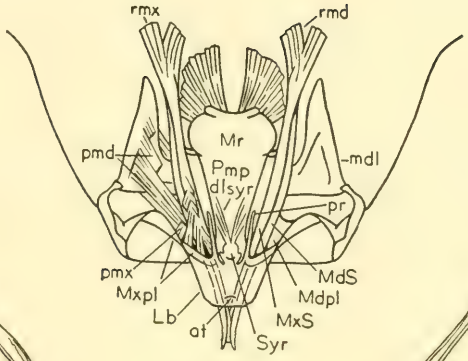

FIG. 29

FIG 30

FIG. 31

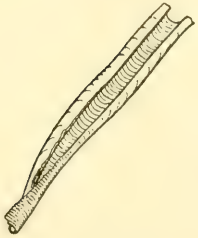

FIG. 32

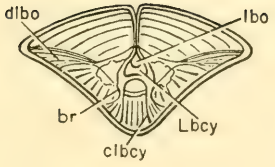

FIG. 33

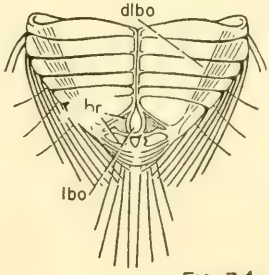

FIG. 34

PLATE XXII

FIG. 35. Anterior view of prothorax.
FIG. 36. Posterior view of prothorax.
FIG. 37. Ventral view of prothorax.
FIG. 38. Lateral view of prothorax.
FIG. 39. Lateral view of pterothorax.

PLATE XXII

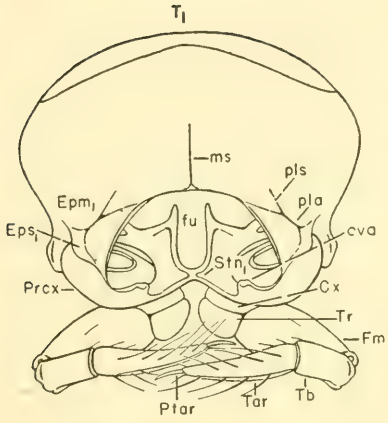

FIG 35

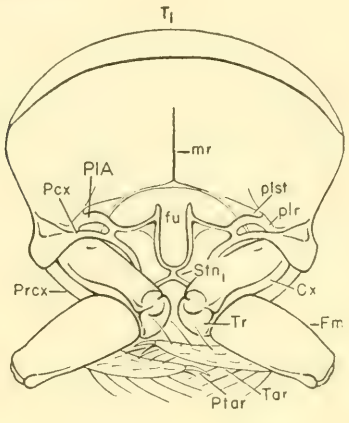

FIG. 36

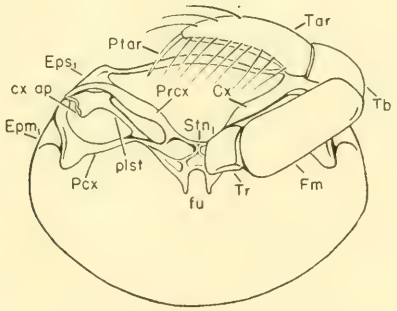

FIG. 37

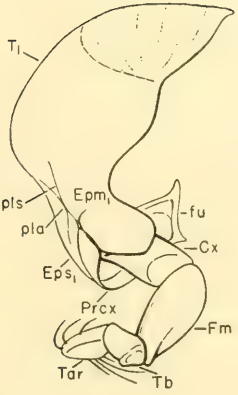

FIG. 38

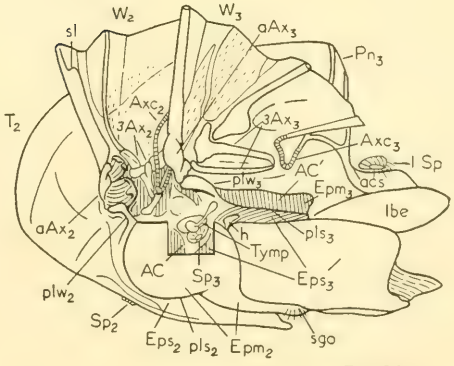

FIG. 39

PLATE XXIII

FIG. 40. Dorsal view of pterothorax.
FIG. 41. Ventral view of pterothorax

PLATE XXIII

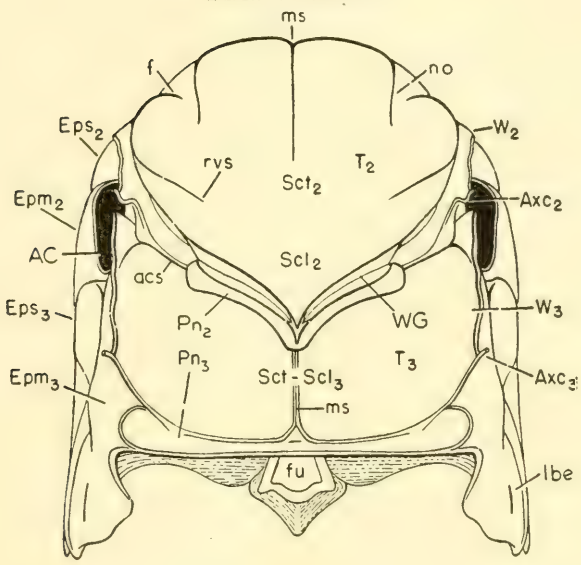

FIG. 40

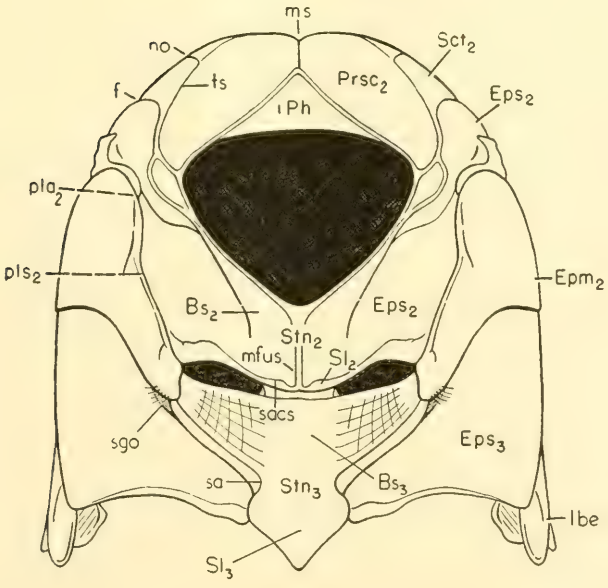

FIG. 41

PLATE XXIV

FIG. 42. Median sagittal section (*Arctocorixa sp.*).
FIG. 43. Median sagittal view within pterothorax and basal abdomen.

PLATE XXIV

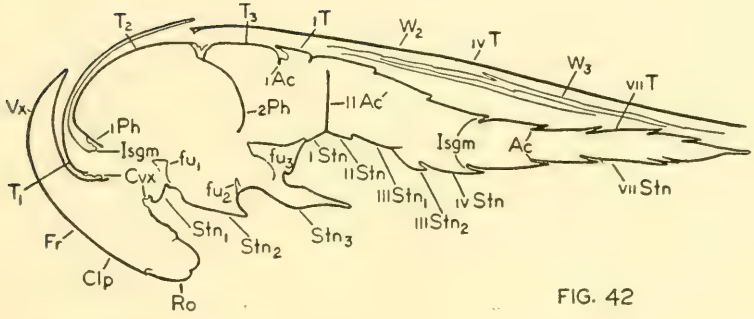

FIG. 42

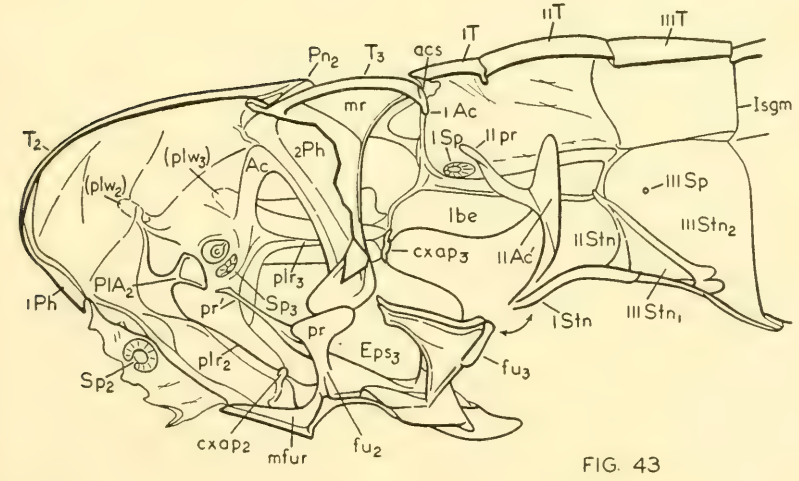

FIG. 43

PLATE XXV

FIG. 44. Posteroventral view of left prothoracic leg of female.

FIG. 45. Anterodorsal view of left prothoracic leg of female.

FIG. 46. Anterodorsal view of left prothoracic leg of male. **Figs. 44-46 are much enlarged in comparison to other figures.**

FIG. 47. Anteroventral view of left mesothoracic leg.

FIG. 48. Anteroventral view of left metathoracic leg.

PLATE XXV

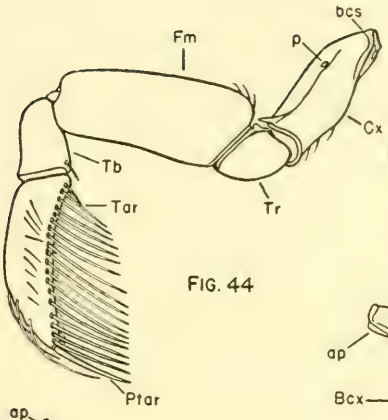

FIG. 44

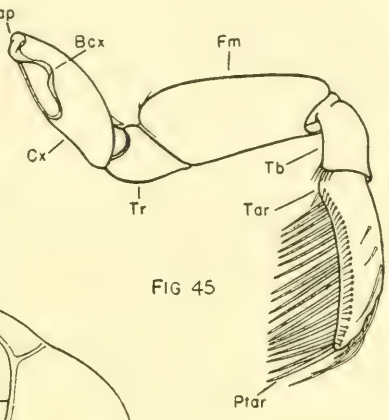

FIG 45

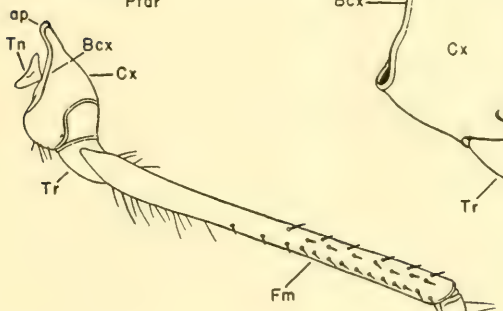

FIG. 47

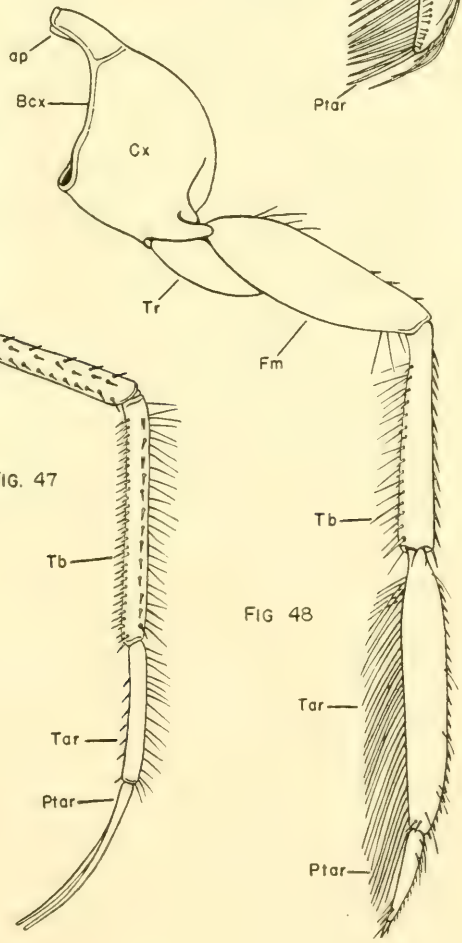

FIG 48

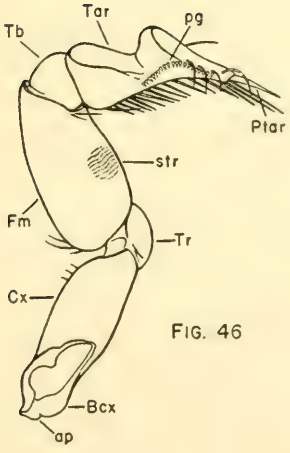

FIG. 46

PLATE XXVI

FIG. 49. Dorsal view of right mesothoracic wing.
FIG. 50. Dorsal view of right metathoracic wing expanded.

PLATE XXVI

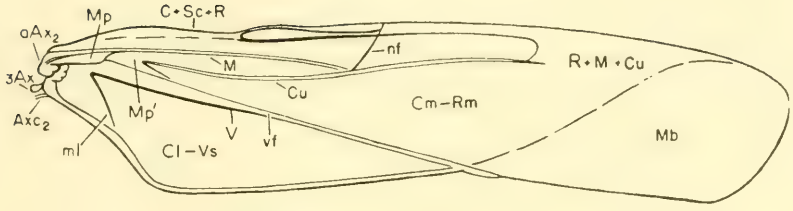

FIG. 49

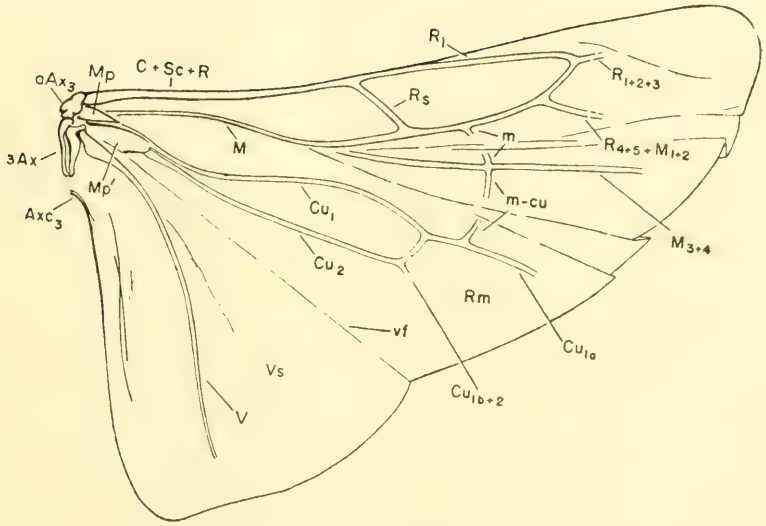

FIG. 50

PLATE XXVII

FIG. 51. Dorsal view of female abdomen.

FIG. 52. Ventral view of apex of female abdomen.

FIG. 53. Ventral view of female genital capsule.

FIG. 54. Diagram of partial cross-section of fourth abdominal segment (*Arctocoriza sp.*).

PLATE XXVII

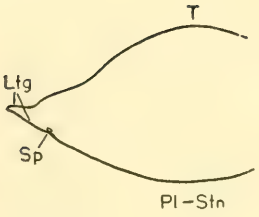

FIG. 54

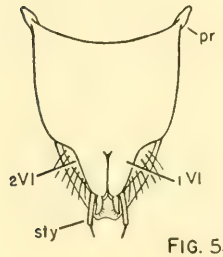

FIG. 53

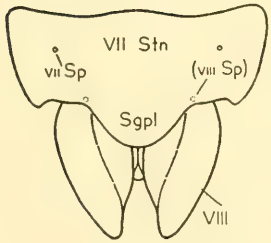

FIG. 52

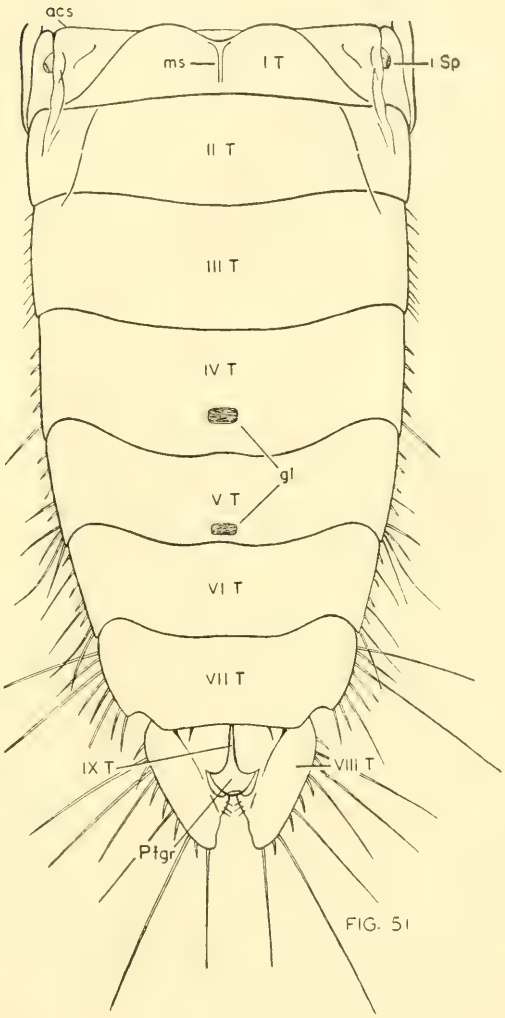

FIG. 51

PLATE XXVIII

FIG. 55. Dorsal view of male abdomen.
FIG. 56. Ventral view of male abdomen.
FIG. 57. Dorsosinistral view of male genital capsule.
FIG. 58. Ventrodextral view of male genital capsule.

PLATE XXVIII

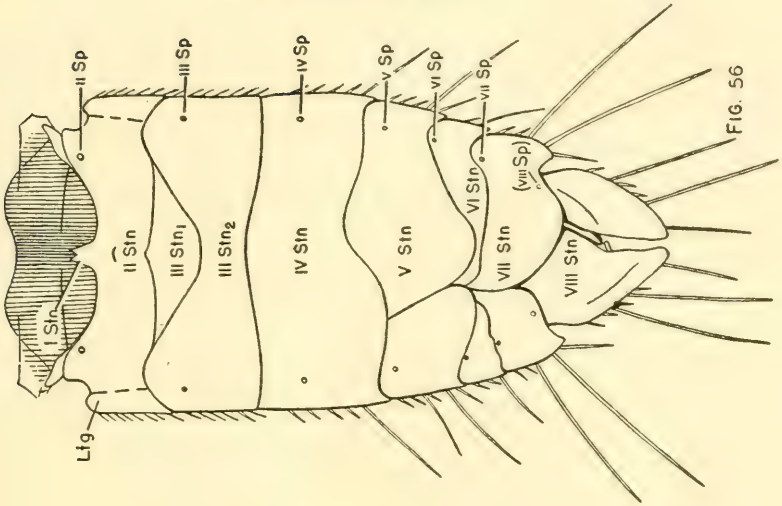

FIG. 56

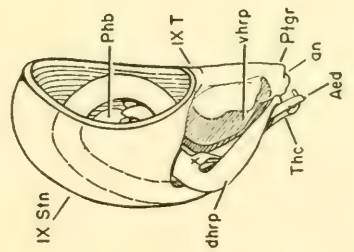

FIG. 57

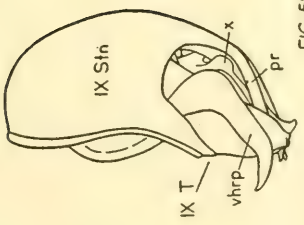

FIG. 58

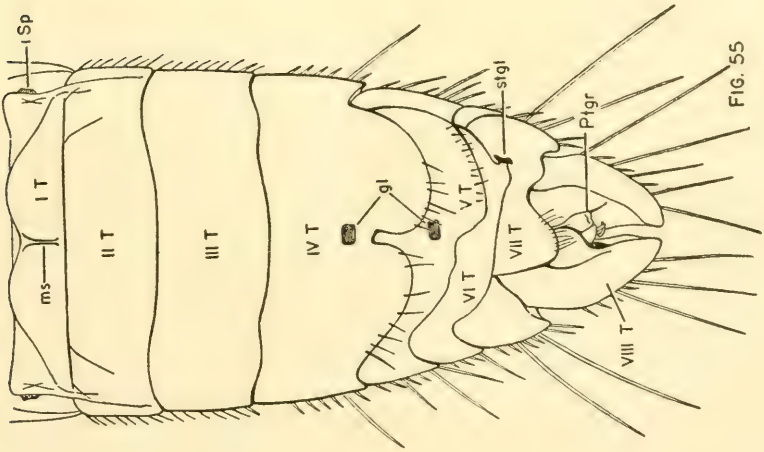

FIG. 55

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXX, pt. II.] JUNE 15, 1945 [No. 15

Revision of Nearctic Bibionidae Including Neotropical Plecia and Penthetria (Diptera)*

By D. ELMO HARDY

ABSTRACT: A monographic study of all the known Nearctic species of the Dipterous family Bibionidae, including the Neotropical Plecia and Penthetria, bringing up to date the taxonomy and known data concerning these flies. Keys to the genera of the New World and keys to species as follows: *Penthetria*, New World species based upon males; *Plecia*, New World species based largely upon males; *Bibio*, keys to both males and females; *Bibiodes*, key to species; *Philia*, keys to both males and females. New species: *Penthetria appendicula, distincta; Bibio albipennis beameri, carolinus, townesi; Philia tingi.* Nomenclatorial changes: *Bibio carolinus*, n. n. for *B. afer* McAtee; *Bibio neojacobi*, n. n. for *B. jacobi* Hardy (nec Villeneuve); *Plecia confusa* Loew for *P. ruficollis* Fabr. 1805. Synonymy: *Dilophus* Meigen syn. of *Philia* Meigen; *Eupeitenus* Marquart syn. of *Penthetria* Meigen; *Penthera* Philippi syn. of *Plecia* Wied.; *Rhinoplecia* Bellardi syn. of *Plecia* Wied.; *Spodius* Loew syn. of *Hesperinus* Walker; *Bibio currani* Hardy syn. of *Bibio bryanti* Johnson; *Bibio currani* var. *nigrita* Curran syn. of *bryanti* var. *nigrita* Curran; *Bibio fumidus* Coquillett syn. of *inaequalis* Loew; *Bibio fuscipennis* Macquart syn. of *femoratus* Wied.; *Bibio hirtus* Loew syn. of *albipennis hirtus* Loew; *Bibio humeralis* Walker syn. of *xanthopus* Wied.?; *Bibio jacobi rufitibialis* Hardy syn. of *neojacobi rufitibialis* Hardy; *Bibio lacteipennis* Curran (nec Zett) syn. of *bryanti* Johnson; *Bibio lucens* Hardy syn. of *nigripilus* Loew; *Bibio lugens* Loew syn. of *xanthopus* Wied.; *Bibio macateei* James syn. of *xanthopus* Wied.; *Bibio obscurus* Loew syn. of *xanthopus* Wied.; *Bibio pallipes* Say syn. of *abbreviatus* Loew?; *Bibio scita* Walker syn. of *xanthopus* Wied.?; *Bibio senilis* Wulp syn. of *femoralis* Wied.; *Bibio signatus* Hardy syn. of *xanthopus palliatus* McAtee; *Bibio simplicis* Curran syn. of *inaequalis* Loew; *Bibio tenuipes* Coquillett syn. of *albipennis tenuipes* Coquillett; *Bibio thoracica* Say syn. of *rufithorax* Wied.; *Bibio variabilis* Loew syn. of *nervosus* Loew; *Penthetria costalis* Walker syn. of *nigerrima* (Bellardi); *Penthetria longipes* Loew syn. of *heteroptera* (Say); *Philia dimideatus* Loew syn. of *spinipes* (Say); *Philia occipitalis* Coquillett syn. of *breviceps* (Loew); *Plecia flavimaculata* Hunter syn. of *flavimacula* Walker; *Plecia funebris* (Fabr.) syn. of *plagiata* Wied.?; *Plecia heteroptera* Macquart syn. of *plagiata* Wied.; *Plecia minor* Jaennicke syn. of *similis* Rondani; *Plecia rostrata* Bellardi syn. of *rostellata* Loew; *Plecia thoracicus* Say syn. of *spinipes* (Say); *Plecia velutina* Macquart syn. of *maura* Walker; *Plecia vittata* Bellardi syn. of *plagiata* Wied.

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TABLE OF CONTENTS

PAGE
Introduction 369
Distribution 369
Phylogeny 369
Economic Importance 370
Control measures 373
Biological control 374
Wing venation 375
Female reproductive system 375
Oviposition 376
Life history and immature stages 376
Egg 376
First instar larvae 377
Other larval stages 377
External morphology 377
Digestive system 378
Pupa 379
Male genitalia 379
Fossil Bibionidae 380
Systematic treatment 381
Key to genera of New World 381
Hesperinus Walker 382
Penthetria Meigen 384
Key to New World species based upon males 384
Plecia Wiedemann 390
Key to New World species based largely upon males 391
Bibio Geoffroy 444
Key to species, males 444
Key to species, females 447
Bibiodes Coquillett 494
Key to species 494
Bibionellus Edwards 496
Philia Meigen 497
Philia Meigen vs. *Dilophus* Meigen 497
Key to species, males 498
Key to species, females 499
Acknowledgements 515
Index 517
Explanation of Plates 522, 524, 526, 528, 530, 532, 534, 536, 538, 540, 542, 544, 546

INTRODUCTION

SINCE McAtee's monograph of the Bibionidae[1] comparatively little attention has been given to this family in America. Doctor M. T. James, Doctor C. H. Curran, Mr. W. L. McAtee and the writer have made contributions to the literature since that time, a good many species have been added and many systematic changes have been made, so that a revisional study of this group is now badly needed. The foundation work on American Bibionidae was done in the early part of the nineteenth century by Say, Macquart, Loew, Walker, Fabricius, Wiedemann and Jaennicke and many of the types of the early species have been lost or are not at the disposal of American workers; consequently a good many of these have been difficult if not impossible to place. The earlier descriptions, for the most part, are very inadequate and do not present substantial specific characters. While making this study the writer has examined all of the available types of New World species and has had specimens compared with types in European museums whenever possible. The types of some species have not been located and accurate placement of these is questionable.

The Bibionidae are almost world wide in distribution, some genera such as *Plecia, Philia* and *Penthetria* are more abundant in the tropics and but poorly represented in temperate climates, while species of *Bibio* are numerous in temperate regions, and rather rare in the tropics. The genus *Bibiodes* is apparently confined to North America and *Bibionellus* is known only from Bolivia. The geographical regions of South and Central America contain very interesting species complexes, various species of the genus *Plecia* appear to be especially restricted in their distribution.

In position the Bibionidae stand between the Mycetophilidae and the Scatopsidae. For some time the latter were included in the family Bibionidae; this accounts for Malloch's *Forbesomyia* [2] being described as a Bibionidae. Enderline [3] separated the two families in 1912 and Melander [4] in 1916 applied the separation to the American species but neglected to treat *Forbesomyia,* which is distinctly a Scatopsidae. Alexander's *Cramptonomyia* [5] has been placed in the Pachyneuridae, along with its closest relative, the *Pachyneura.* The

1. 1921, Proc. U. S. Nat. Mus. 60, 1-27.
2. 1913-15, New genus of Bibionidae, Bull. Ill. State Lab. of Nat. Hist. Vol. X, pp. 233-5.
3. 1912, Zur Kenntnis der Zygophthalmen. Zoöl. Anz. XI, 261-82.
4. 1916, Bull 130, State Coll. Wash. Agri. Expt. Sta.
5. 1931, New genus of Bibionidae. Bull. Brooklyn Ento. Soc. Vol. XXVI, 7-11.

genus *Hesperinus* approaches rather closely some of the Mycetophilidae, but the presence of the complete second basal cell of the wing and the lack of well-developed spurs of the posterior tibiae places it as a primitive Bibionidae. The genus *Eupeitinus* Macquart [6] is obviously the same as *Penthetria* Meigen, as is discussed in the synonomy under *Penthetria*. The name *Eupeitinus* has been used by Van der Wulp [7] when he identified *Eupeitinus atra* Macquart from Wisconsin and by Walker [8] who referred two specimens to this species; this is obviously a synonym of *Penthetria heteroptera* (Say). Coquillett [9] reëstablished the genus, but McAtee [10] stated that the species used by Coquillett belonged to a new genus (*Axymia*) of Tipulidae. The genus *Axymia* has since been placed in the family Anisopodidae. Enderline [11] recently keyed the genera *Axymia* and *Pachyneura* as Bibionidae, but this is either an error or a difference in interpretation of the family limitations.

ECONOMIC IMPORTANCE

Several species of Bibionidae are considered major pests in various parts of Europe and the Far East, and perhaps further investigations of the life histories of our American species may prove them of more significance than normally considered. Because of the diversity of feeding habits of the larvae and their occurrence in such enormous numbers in local areas they may be potential pests of quite a wide range of crops. The larvae, for the most part, feed on decaying organic matter and upon roots of grasses and other plants and they most commonly occur in manures, in decaying leaves, in other plant materials and in grassy meadows and pasture lands. Many species appear to be omnivorous in feeding habits and may feed as scavengers, later changing to living plant tissues. It is probable that in many instances where the larvae have been found doing damage they have been carried to the plants in fertilizer. Severe infestations have been reported following heavy applications of manure or humus to the soil.

The information concerning the economic status of our American species is very meager and it is entirely speculative as to their actual importance. There have been numerous reports of their injurious

6. 1838, Dipt. Exot. Vol. I, pp. 84-5.
7. 1869. Tijds. V. Ent., Vol. 5, p. 80.
8. 1848, List of Dipt. in British Mus. 1.
9. 1909, Re-discovery of the Bibionid Genus Eupeitenus, Ent. News, V. XX, No. 3, p. 106.
10. 1931, Description of a New Genus of Nemocera (*Axymia furcata*). Proc. Ent. Soc. of Wash. Vol. 23, p. 49.
11. 1936, Dipt. Tierw. Mittel. VI.

activities and many observations have been recorded which suggest that they may be injurious. Damage to celery, wheat and potatoes has been reported from Alberta, Canada, by Strickland.[12] He states: "In 1914, when the celery was dug on October 24th, it was found that the soft pulp between the fibrovascular bundles of the stalks had been eaten away to an average depth of 1.5 mm. (1/16 inch). The work of the individual larva does not extend for more than about one-fourth inch between two of the vascular ridges. A large number of larvae swarm around infested plants, however, so that the whole of the portion of the plant which is below ground—some nine inches in length— may be affected. Towards the base of the plant, damage is most severe, and the excavations are often confluent, extending for two or three inches in length between the ridges, . . . Rarely the larvae burrow deeply into the pulp thus forming small tunnels, . . . The attacked areas turn brown during the late summer and autumn and are the seat of infection for various fungus diseases and small dipterous larvae, such as *Drosophila* which soon render the plants unfit for the market."

The damage to wheat in Canada occurred usually before the plants had sprouted above the ground, but sometimes the attacks occurred after they were well above the ground. Concerning the potato damage in Canada, Professor Strickland stated in correspondence that the larvae were found in very large numbers in a potato patch near Edmonton: "Insofar as I could judge the potatoes had been damaged by wire worms and the larvae had entered in this manner, but they were sufficiently numerous to entirely hollow out some of the tubers." Several reports of potato injury have been made, for instance, the writer has observed rather severe damage done by *Bibio melanopilosus* Hardy larvae in gardens at Spanish Fork, Utah.

There are occasional reports of injury in vegetable gardens, in grain fields and to forage crops, but most of these are entirely unconfirmed by experimental data. It is not at all uncommon to find the adults emerging in enormous numbers from fields of grain, potatoes, alfalfa, and other crops, but it is seldom that any actual damage is evident. To date, however, no checks have been set up to obtain a direct comparison between infested and noninfested plots.

In Europe Bibionidae are occasionally destructive to cereal and other crops. Experiments have shown that the larvae prefer barley, rye, sugar beets, and hops to all other plants. *Bibio hortulanus*

12. 1916, Agri. Gaz. Canada, 3, 600-603.

Linnaeus (Die Gartenhaarmücken) is no doubt the most important economic species. This fly has at various times been reported doing serious damage to crops in Germany, Denmark, Bavaria and Poland. Maier[13] in 1936 reported losses of ninety percent of the rye crops in fields near Berlin and other parts of Prussia due to this pest. He states that the injury usually occurs in spring just after the cereals have sprouted but sometimes occurs after the crop is several inches high. The *Bibio* larvae were found to work about two inches below the surface and attacked the stems below the first node. His observations showed that fields in high areas were most frequently attacked and in all cases were near woods. Muller[14] found that *B. hortulanus* females oviposited under crop remnants on beet and potato fields and the larvae fed on potato tubers, sugar beets, garden plants and especially germinating cereals. Sugar beets are subject to severe injury in Western Europe and the young shoots of the beet seedlings are sometimes entirely eaten.

Aside from these crops the larvae have been reported attacking the roots of oats, wheat (in many instances the damage being so severe that the fields had to be plowed up and resown), lettuce, seedling cabbage, grasses, young flowering plants, tomatoes, young conifers, seedling ash, larch, spruce and other nursery stock as well as forage crops, pasture lands and bowling greens. Morris[15] estimated that 32.5 percent of the insect population of the permanent pasture lands of Cheshire, England, were Bibionidae larvae; a population of almost 1,200,000 individuals per acre.

Adult Bibionidae have been reported doing damage to blooming fruit trees, but this seems rather absurd and there is no actual evidence to this effect. Field observations and study of their mouthparts seem to contradict this, and on the contrary, they are probably beneficial in distributing pollen. They are thought to feed upon juices of plants. Sabrosky[16] states, that he has observed *Bibio painteri* James feeding in association with the Chrysomelidae beetle, *Gastroidea cyanea* Melsh. He reports that "numerous Bibionids had their mouthparts appressed against the freshly cut edges of the leaves (cut by the beetles), apparently sucking the plant juices." This is one of the few observations that have been made of the actual feeding habits of the adults.

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13. 1936, Nachr. Bl. dtsch. Pfl. Sch. Dienst. 16, 10.
14. 1930, Ueber Die Lebensweise und Bekampfung der Gartenhaarmücken. Fortschr. Landw. 613.
15. 1920, Ann. Appl. Biol.
16. 1935, Jour. Kan. Ent. Soc. No. 4, 145-6.

CONTROL MEASURES

The best recommendations for prevention of Bibionid injury seem to be to remove all debris from the fields and to plow deeply in the fall and again before spring planting. When the eggs or larvae are turned under, the adults are unable to reach the surface and those that are turned up will die of exposure or be eaten by birds. In areas where infestation is common the use of artificial fertilizers instead of natural manures seems to be the most practical measure. Many recommendations for traps and use of chemical poisons and repellents have been made by various writers, but most of these would not be practical unless infestations were severe. Robek[17] recommends placing slices of potatoes on end in the soil as attractants for the larvae. After three or four days these slices are then removed and thrown into hot water. Other traps are by means of old roots buried in the soil and dug up early in March when the larvae are feeding on them. Vassiliev[18] states that the adults may be captured in great numbers in fermenting molasses. Molz[19] says that potato skins steeped in a one percent solution of arsenious acid give an attractive and effective poison bait. Goidanich[20] has reported that complete protection for seed potatoes is obtained by dipping them in a one percent suspension of lead arsenate in water with addition of thirty percent gypsum. Sudeikin[21] has recommended spraying infested land with a solution of chili saltpeter in early spring, and harrowing in autumn or early spring after spreading quicklime on the field. Hornik[22] reports that a 1-2 percent spray of tobacco extracts containing 7 percent nicotine sulphate applied to the soil at about 55 gallons to the acre killed 42-52 percent of the larvae as compared with a 6 percent death rate in untreated soil. Bovien[23] states that the most effective control measure is to dust the manures and leaves with chemicals such as arsenicals and lime. Abraham[24] reports that excellent results were obtained by using calcium cyanamide as a top dressing at the rate of 180 to 280 pounds per acre and that the young plants were unharmed. (This procedure certainly would not be practical under ordinary field conditions.)

17. 1930, Muchnice dubnova. Ochr. Rost. X, No. 3, 73-74.
18. 1915, Herald of Sugar Industry. Kiev. XVI, No. 22, 511.
19. 1920, Zeitschr. Angew. Entom. VII, 92-96.
20. 1933, Un. Nuovo metodo di difesa delle Patate da Semina Contro il. Italia Agric. LXX, No. 2, 183-186.
21. 1913, Pests of Agri. Plants in Gov't of Voronezh. pub. by Zemstvo, Voronezh.
22. 1931, Ochr. Rost., XI, No. 3-4, 115-120.
23. 1932, Tidsskv. Planteavl. XXXVIII, 488-498.
24. 1936, Nachr. Bl. dtsch. PflSchDienst, 16, No. 2, 22.

Theobald [25] states that vaporite and injections of carbon bisulphide into the soil gave a satisfactory kill. Maier [26] applied a top dressing of potash to drive the larvae to lower depths "but no definite estimate of the value of this measure could be made because of subsequent frosts." Boning [27] found that the larvae of *B. hortulanus* L. were very resistant to damp soils and water immersion, making the older recommendation of flooding lands an impractical control method. He states that the larvae survived a twenty-four-hour immersion in water without apparent injury. They died in two to three hours when exposed on a hard surface in the dry air but lived for two days in quite dry soil.

BIOLOGICAL CONTROL

Robins, pheasants, poultry, starlings, chaffinches and rooks et al. have been reported by various authors to feed upon Bibionidae, and insectivorous birds are no doubt instrumental in keeping them in check. Lyonet[28] reported finding a mite on a Bibionid and a filarial worm inside one. Keilin[29] reported a Gregarine, *Schneideria mucronata* Leger, occurring in the mid-gut and anterior caeca of Bibionid larvae together with a bacterial disease. Morris[30] reported a *Schneideria* in the posterior caecum of a *Philia febrilis* Linn. larva, and two cysts full of spores were found free in the body of the same larva. Another parasite, probably a *Glugea,* was found infesting the epithelium of the alimentary canal of *Bibio johannis* Linnaeus; such a *Microsporidian* was mentioned in Keilin's paper invading the epithelial cells of the mid-gut and caeca of Scatopsid larvae. Morris described the larva and pupa of a Phoridae (*Hypocera incrassata* Mg.) parasite of *Bibio marci* Linn. The Plantesygdromme i Danmark[31] states that *Bibio ferruginatus* Linn. and *B. hortulanus* Linn. had been causing injury to barley and that they suddenly disappeared; studies at this time showed up to 100 percent of the larvae to be parasitized by a Diapriid (*Spilomicrus sp.*). Malloch[32] mentions a hymenopterous parasite, but the host relationship was questionable. Adrianov[33] reports the larvae of *Agriotes* (Elateridae) killing *Bibio marci* L. larvae.

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25. 1909, Journ. of Board of Agri., Oct., 567.
26. 1936, Nachr. Bl. dtsch. PflSchDienst, 16, No. 1, 10.
27. 1931, Pra Kt. Bl. Pflanzenbau u. Pflanzenschutz, IX, No. 7-8, 145-160.
28. 1832, Recherches sur les Insects (Mem. Pesth.).
29. 1919, Ent. Monthly Mag. (3) v.; 92-96.
30. 1921, Bull. of Ento. Res. XII, 231.
31. 1932, Tidsskr. Planteavl. 39.
32. 1917, Bull. Ill. State Lab. of Nat. Hist. XII.
33. 1914, Report of Pests of Field Crops, pub. by the Zemstvo of Gov't of Kaluga, 67-88.

WING VENATION

The interpretation of the wing veins is the same as that used in Dorilaidae, however, the venation is much more generalized. The subcostal vein is weak in most genera and often ends before the wing margin. R_1 and $_2$ are fused and in higher genera R_3 and $_4$ are also apparently fused in the first branch of radius. The genera *Hesperinus* and *Penthetria* show the more primitive position of vein R_{3+4}, in a more horizontal position and forking off from the distad portion of the posterior branch of radius. *Penthetria appendicula* n. sp. possesses a stub of a vein just above the forking off from the main stem (fig. 122c) which probably represents a remnant of the base of R_3, suggesting that it originally forked off from vein R_2. In the genus *Plecia* R_{3+4} has moved cephalad and is more vertical in position, approaching vein R_{1+2}. In *Plecia incurvata* Hardy the tip of R_{3+4} fuses with R_{1+2} (fig. 147b). In higher genera vein R_{3+4} has apparently migrated basally and disappeared in the axil of the radial sector, fusing with R_{1+2} or dropping out entirely. This basad migration is easily traced from the Bibionidae through the Mycetophilidae and Blepharoceridae. Vein R_5 is simple and in the genus *Bibiodes* (fig. 205c) this vein joins with media for a short distance, obliterating the r-m crossvein. Media is three branched, the portion interpreted as m-cu crossvein by Comstock-Needham is now known as the base of M_{3+4} and the base of Cu_1 of Comstock-Needham is the m-cu crossvein. Cu_1 and first A are usually strong veins and often converge at their apices so that the cubital cell is narrowed in the wing margin.

FEMALE REPRODUCTIVE SYSTEM

The following is the information gathered by dissection of the reproductive system of *Philia orbatus* (Osten Sacken). The gravid females have the entire abdomen filled with eggs and each ovary contains two to several hundred eggs. All of the eggs are of approximately the same size and are deposited in one mass at a single oviposition. From ventral view the eggs are usually in two main rows, from dorsal view most of the eggs are seen in end view and are arranged in several transverse rows, those in the posterior portion of the ovaries are usually lying flat and pointed toward the oviduct. No distinct ovarioles are visible and the lateral oviducts are very short with the common oviduct extending anteriorly about one-third the length of the ovaries. From all appearance the eggs are emptied directly into the common oviduct which opens into the

genital cavity of the eighth segment. The spermathecae are triple, conspicuous, large and black and branch off from the ventral portion of the median oviduct posterior to the ovaries. The accessory glands are distinctively shaped, green in color and attached to the ventral side of the common oviduct (fig. 110a). The eggs in about the middle of the ovaries enter the oviduct first, small end of egg pointed posteriorly, then the others are released in a sequence according to their natural position.

OVIPOSITION

Copulation usually takes place about twelve hours after emergence and the gravid female soon begins looking for a suitable place to oviposit; she flies very slowly with some difficulty, usually spending much of her time near the ground in grasses and weeds. The average length of life appears to be about three days, the male usually dies shortly after copulation and the female after oviposition. In studying oviposition habits gravid females are confined in cages or cloth covered glass jars in which has been placed a few inches of moist earth. The female then selects a suitable spot and begins digging out a burrow by means of the fossorial spurs of her front tibiae. The tarsi fold back and the fly digs by moving the front legs up and down in front of her head, scraping out the earth until the hole is large enough for her body, then she squeezes into it and gradually works downward to a depth of one to four inches. At the bottom of this burrow the fly enlarges the chamber and deposits her egg mass. After oviposition the female appears entirely exhausted and soon dies, usually never leaving the burrow.

EGGS

Each egg mass ordinarily contains two to three hundred eggs, these are cylindrical, oblong, rounded on each end and larger on one end. When first laid the eggs are pale whitish to faintly yellowish, but slowly turn darker, especially at the ends, as they grow older. The eggs are faintly shining and microscopically sculptured, being covered with very minute projections. The sculpturing of the chorion may show specific characteristics if studied in detail. The eggs are .50 to .90 mm. in length, and .10 to .20 mm. in width, depending upon the species. Under laboratory conditions the eggs of *Bibio* hatch in twenty to forty days, depending, of course, upon the season. Most all of the eggs hatch at approximately the same time and the larvae develop at an even rate, accounting for the sudden large swarms of adult flies which appear in the spring. The length of the incubation period varies with the species and with the ecological conditions.

LARVAE

The earliest description of a larva and pupa of *Bibio* was that of Reaumur.[34] This early work figures and describes the larvae and pupa of *Bibio marci* Linnaeus. "St. Marks fly." The earliest work encountered in America is the account by Kellogg, 1893, Trans. Kan. Acad. Sci. which discusses the larvae and pupae of *B. tristis* Williston and the account by Needham[35] of *Bibio fraternus* Loew, in which he describes and figures the larva and pupa. The paper by Girault[36] is also commendable and gives some very valuable observations on the life history of the March fly. The contributions of H. M. Morris[37, 38, 39] on the immature stages of English Bibionidae are by far the best works on this subject.

The first instar larvae of *Bibio* vary in length from 1.3 mm. to 1.8 mm. The head is comparatively large and more heavily sclerotized than the rest of the body. The trunk is divided into twelve distinct segments, each segment, as well as the head, bearing numerous long setae on all first instar *Bibio* that have been recorded. The first instar larvae of *Philia* differ from *Bibio* in having only short setae. The larvae are pale yellowish in color, with the contents of the alimentary canal usually plainly visible through the integument as a dark median line. The body is cylindrical in shape and usually slightly curved. From all observations that have been made the first instar larvae bear but a single pair of spiracles, these are situated on the twelfth segment of the trunk. *Bibio johannis* Linnaeus required nineteen days, under laboratory conditions, before moulting to the second stage according to Morris.[40]

With the first moult the larvae lose all of the long setae on the body and develop characteristic microscopic scalelike spicules on the cuticula. The head of the second instar is not so proportionately large as in the first. The full grown larvae vary from six to twenty-eight millimeters in length, according to the species. The head is protruded, barely longer than wide and shining brown, darker, more strongly sclerotized than the trunk. The anterior portion of the head is darker in color and bears several strong setae, the hind portion is lighter brown and bare, capable of being retracted into the first segment of the trunk. Eyes are lacking and the antennae are

34. 1741, Memoires des Insects, 5; 70.
35. 1902, American Naturalist, vol. XXXVI, 181-185.
36. 1905, Can. Ent. 37; 322.
37. 1917, Ann. of Applied Bio. IV, 91-114.
38. 1921, Bull. of Ento. Research, XII, 221-232.
39. 1922, Bull. of Ento. Research, XIII, 189-195.
40. 1917, Ann. Applied Bio. IV, 94.

small and setiferous. The mandibles are strong and heavily sclerotized; the number of the teeth appears to vary in different species and the shape of these structures may prove of taxonomic importance. The inner surface of each mandible possesses a characteristic clump of fine long hairs near its median portion (fig. 111a). The maxillae are short and stout and bear numerous strong spinelike setae at the apices of the palpi and the endite lobes of stipes (fig. 111b). The labium is quite characteristic in different species, the mentum is usually about one and one-half times the width of the submentum, slightly concave on apical margin and lighter in color, less heavily sclerotized than the submentum. The submentum is rather dark in color with a lighter median area and a small clump of short spines in the distal portion of this pale area. The apex of the submentum is slightly to deeply concave, reaching almost to the distal margin of the mentum in some species and much beyond in others. The labrum is divided into two lobes by a median indentation at the apex, the distal portion is armed with short, stout teethlike spines while the under portion is thickly covered with short closely set setae.

The body of the mature larva is subcylindrical, slightly flattened dorsoventrally with a slight downward curvature of the body as seen from lateral view. The trunk is distinctly twelve segmented, the first segment is the longest and sometimes may appear partially divided, but as Morris has pointed out, the imaginal disks prove it to be a single segment. The body possesses ten pairs of spiracles, a pair being located on all segments of the trunk except two and eleven. The spiracles are usually darker in color than the rest of the integument and may be partially protruded. The posterior pair are two to four times as large as any of the other spiracles, they are more dorsal in position and appear to have two or more openings. The other spiracles are laterally placed and each has just a single opening. The first pair is located toward the posterior margin of the segment and is larger than the others (except twelve), while those of segments three to ten tend to be situated nearer the anterior margins. The integument is covered with characteristic rows of spines and processes as well as microscopic scalelike spicules. These spicules are of varying sizes and shapes and from the little investigation that this phase has received it would appear that these may represent specific characters for distinguishing the larvae. The spicules differ chiefly in the number and position of the short, sharp pointed spines which they bear, or as in the case of *Bibio lacteipen-*

nis Zett. (fig. 112a) the lack of spines. In other species that have been studied the spicules have from one to seven or eight pointed processes (figs. 111c-120a). On most any larval slide it is possible to pick out spicules bearing different numbers of spines but the greater share of them tend to fit a specific pattern. Mr. P. C. Ting, San Francisco, Cal., has made investigations along this line and was the first to call it to the attention of the writer.

Concerning the digestive system of *Bibio marci* Linn. Morris states: "The alimentary canal takes an almost straight course through the body, but has a loop near the posterior end, in the hind gut. The largest part of the alimentary canal is the mesenteron, which bears three large caeca at its anterior end, one lying on each side and the third, which is the largest, places ventrally. The four malpighian tubes join the alimentary canal at the junction of the mesenteron and hind gut, entering the canal by a short common duct on the dorsal side. There is no posterior caecum such as is found in connection with the alimentary canal of *Bibio johannis*."

PUPA

The pupae are rather long and slender, slightly tapering toward the posterior portion, the cuticle is pale white, smooth and transparent in the newly formed pupae, the darker parts of the head and thorax showing plainly through the integument; the abdomen remains pale in color until after emergence. The females are usually larger in size and may be distinguished from the males by the small eyes and more abruptly narrowed anterior end. The large, slightly protruded eyes of the male will characterize this sex as in the adults. The anterior portion of the pupal case is often armed with small projections. The head is pressed down flat against the anterior part of the thorax and the short antennae are extended laterally over the eyes. The thorax is short and the legs and wing cases are closely pressed together on the venter. When the adult emerges the mesonotum splits down the longitudinal ridge at the middle of the dorsum allowing the fly to escape. The pupal stage requires approximately two weeks for the species which have been studied.

MALE GENITALIA

The genital structures of the male Bibionidae are very important taxonomically, especially in genera other than *Bibio*. In the *Plecia*, *Penthetria* and *Philia* the genital characters serve as the only criteria for separating many of the species. The characters that are most useful in the systematics of the family are: The depth and shape

of the cleft on the posterior margin of the ninth sternum or the general shape of the entire sclerite; the lateral margins may be strongly or weakly produced and the posterior margin is sometimes strongly developed. The degree of concavity or convexity of the posterior and anterior margins of the ninth tergum and the relationship of the length of sclerite to its width. The shape and development of the harpagones is usually distinctive for the species and all degrees of specialization are seen in these structures throughout the family. In the genus *Philia* the exact shapes of the harpagones are sometimes difficult to discern, giving rise to various interpretations according to the angle from which they are viewed. It is especially necessary in the latter genus to relax the genitalia before the true relationship of the parts can be observed. The accessory structures of the aedeagus and the shape of the cerci are often of importance in distinguishing species.

FOSSIL BIBIONIDAE

The chances for Diptera of this kind being preserved would be very slight, their comparatively soft integument and the dissolution of chitin in the presence of moisture would prevent the fossilization of more than a representation of the forms. Because of this it is difficult to estimate the probable abundance on a basis of the specimens that have been fossilized. *Protoplecia* Handlirsch dates back to upper Liassic (Middle Jurassic) and represents the oldest known member of this family. There is some question as to whether or not this is properly placed and it possibly belongs to some related family and does not represent a primitive Bibionidae. Only a single species, *Bibio sereri* Massalongo is listed by Handlirsch [41] from Eocene deposits, so these flies were either rare at this time or conditions were not favorable for fossilization. The Bibionidae apparently enjoyed their heyday in the middle and late Tertiary period. From the fossil evidence they must have been one of the most numerous groups of insects at that time. Bibionidae remains are very abundant in most Oligocene and Miocene deposits although they are not at all common in the Baltic Amber. These flies are among the most characteristic fossils of the Florissant shales and Creed formations of Colorado. Most of the fossil Bibionidae belong in present-day genera and most of the species appear to approach our modern forms very closely, some may even be identical.

Freak individuals are rather common in the Bibionidae. It is not

41. 1908, Die Fossilen Insekten; 961.

at all unusual to find malformations of various appendages, especially the legs, or to find distortions of the head and body. Many specimens have been observed wherein certain leg joints have been atrophied, strongly bowed, or entirely lacking. James [42] reports finding a gynandromorphic specimen of *Bibio monstri* James. Wheeler [43] records a specimen of *Philia tibialis* (Loew) with an antenniform appendage branching from the fore coxa.

SYSTEMATIC TREATMENT

The Bibionidae are readily distinguished from other Nematocera by the absence of the discal cell in the wing, the presence of the two basal cells, and the forking of the radial-sector at or beyond the m-cu crossvein. Ocelli present on a well developed prominence. Antennae (except in *Hesperinus*) rather short, with rounded compact segments, situated below the compound eyes close to the oral margin. Spurs of front tibiae of *Bibio, Bibiodes* and *Bibionellus* strongly developed. The front tibiae of *Philia* are ornamented with two or more sets of spines.

KEY TO THE GENERA OF THE NEW WORLD

1. Third longitudinal vein (main branch of radius) furcate 2
   Third longitudinal vein not furcate (posterior branch of radius simple); front tibiae with large apical spurs or two or more sets of spines 4
2. Antennae very elongate, third segment as long or longer than the next two segments.
   Hesperinus Walker, p. 382
   (Europe, North and South America)
   Antennae more robust, third segment not greatly lengthened 3
3. Vein R_{3+4} short, almost vertical, male harpagones usually small and vertical.
   Plecia Wiedemann, p. 390
   (Cosmopolitan)
   Vein R_{3+4} rather elongate, almost horizontal, harpagones large and lateral
   Penthetria Meigen, p. 384
   (probably world wide)
4. Anterior tibiae produced apically to form two spurs 5
   Anterior tibiae not produced at apices, but with two or more series of spines (fig. 219a) ..... *Philia* Meigen, p. 497
   (Cosmopolitan)
5. Third and fourth longitudinal veins coalesced for a short distance, obliterating r-m crossvein (fig. 205c) ..... *Bibiodes* Coquillett, p. 494
   (North America)
   Third and fourth veins not coalesced, joined by the radio-medial crossvein (fig. 201a) 6
6. Front tibiae each with a conspicuous blunt tubercle in the middle beneath; costa greatly produced, reaching about halfway from R_5 to M_1 .... *Bibionellus* Edwards, p. 496
   (South America)
   Front tibiae without the mid-tubercles; costa ending at the tip of R_5.
   Bibio Latreille, p. 444

42. 1936, Some New Western Bibionidae. Am. Mus. Nov. No. 832.
43. 1896, Arch. f. Entw. Mech. d. Org., V. 3, 26-108, pl. 16.

Hesperinus Walker

Hesperinus Walker, 1848, List of spec. of Dipt. Ins. in Coll. Brit. Mus. 1, 81.
Spodius Loew, 1858, Berl. Ent. Zeitschr. II, 101.

This is the most primitive genus of present-day Bibionidae, it is closely related to the Mycetophilidae in many respects. It is easily distinguished from all other genera in the family by its elongate antennae and the unusual developments of the male harpagones. The wing venation is very similar to *Plecia,* however, the cubital cell is more consistently open wide in the wing margin, vein Cu_1 scarcely curving downward at its apex.

In the Mycetophilidae the genera *Hesperodes* and *Platyura* are related to *Hesperinus.*

Genotype: *Hesperinus brevifrons* Walker.

Hesperinus brevifrons Walker

(Plate XXIX, figs. 121 a-e)

Hesperinus brevifrons Walker, 1848, List of the specimens of Dipterous Insects in the collection of the British Museum, I, 81.

MALE.—Rather slender Bibionidae with long stiltlike legs and elongate antennae. Head and body brown to black with gray pruinose markings. Pile of the body very sparse, short and yellow, the thorax being practically devoid of pile, that of the abdomen more dense posteriorly. Palpi, trochanters, coxae, femora and stems of halteres ochraceous. The antennae, rest of the legs and knobs of halteres pale to dark brown. Antennae twelve segmented, first two segments (scape and pedicel) short; third segment longer than the next two; with rather dense pale pubescence and stronger black hairs intermixed, the latter usually arranged in whirls. Wings dusky hyaline, veins brownish-black, stigma lighter in color and more grayish, distance between anterior crossvein and fork of fourth vein twice the length of the crossvein (fig. 121a). *Genitalia:* This is one of the most interesting and distinctive structures (in Bibionidae) that has been examined by the writer. The unusual development of the clasping structures is really remarkable and no doubt is a generic as well as a specific character. The harpagones are developed into two large lateral arms (figs. 121c-d), the dorsal arm is developed into two projections; one is longer, more flattened laterally and the other is short and developed only about half way up the dorsal lobe on the underside. The cleft on hind margin of ninth sternum is U-shaped, narrowing down considerably at the base, extending nearly one third the length of the segment (fig. 121e). The ninth

tergum is gently concave on hind margin (fig. 121b). The entire genitalia is rather densely haired, these hairs are larger, more spine-like on the distal portion of the ninth sternum. The ninth segment is very noticeably swollen, being much larger than the other segments of the abdomen.

FEMALE.—Differs from the male in having the antennae much shorter but other characters are constant for both sexes, except the genital characters and the enlarging of the male abdomen.

Type locality: St. Martin's Falls, Hudson Bay.

Type in the British Museum.

McAtee reports specimens from Current Creek Valley, Uintah National Forest, Utah. As far as is known by the writer this is the only report for the state. Specimens have been examined from Lake City, Colo., 6-29-37 (C. L. Johnston); Alberta (Strickland), Alaska and New Hampshire.

Hesperinus flagellaria Garrett

Hesperinus flagellaria Garrett, 1925, Sixty-one New Diptera, Cranbrook Courier Print, p. 11.

The writer is unable to distinguish *flagellaria* from *brevifrons* Walker and the two are probably synonymous.

Following is the original description:

"MALE.—Dark brown except the sides of the back of the head, between the dorsal vitta, which are pale dull brown; antennae long, about as long as the abdomen, all yellow brown, 12 segmented, the scape short, cup shaped flagellum cylindrical, segment one very long, about 9 times the length of scape two, flag two less than half one, the rest gradually diminishing to the tip, each with two or three bristly hairs; palpi yellow and large; segment one small; two about equals four, and three half of their length. Wings hyaline, veins brown, stigma black. Hypopygium constructed much as in genus Bibio but larger, eyes bare, tibial spurs very small, legs long. Female similar but the antennae are shorter, only about as long as the thorax; flagellum one about 5 times scape two; flag two less than half of one, segment 8, 9, 10, 11 about as broad as long; 5 and 6 twice as long as broad. Palpi segment one very small, and three nearly equals the length of two which is equal to four."

Type locality: Cranbrook, B. C., Canada.

Type in Garrett Collection.

Penthetria Meigen

Penthetria Meigen, 1803, Illiger's Magaz. II, 264.
Eupeitenus Macquart, 1838, Dipt. Exot. Nouv. ou peu Connus I, 85.
Plecia spp. of many authors refer to this genus.

Entirely opaque black species, usually rather thickly covered with black hair, especially on sternopleurae, hypopleurae, upper portions of propleurae, legs and abdomen. Rostrum not greatly produced, much shorter than the length of antennae. Antennae eleven to twelve segmented. Legs long and slender, posterior tarsal subsegments somewhat swollen in the males of most species. Vein R_{3+4} horizontal or nearly so in position and elongate compared to *Plecia*, Harpagones lateral in position, rather large and conspicuous; for the most part the genital structures do not show great differentiation from a typical pattern.

The species of the genus are very much alike superficially and the genital structures must be relied upon for most specific determinations.

KEY TO NEW WORLD PENTHETRIA

(Based upon males)

1. Hind margin of ninth tergum straight or nearly so..(Mexico) *nigerrima* (Bellardi), p. 388
   Hind margin of ninth distinctly concave or deeply cleft..... 2
2. Ninth tergum deeply cleft on hind margin, the cleft extending at least two-thirds the length of the sclerite..... 3
   Cleft of ninth tergum not extending over one-third the length of the sclerite..... 4
3. Vein R_{3+4} normal, without an appendix at base; ninth tergum almost completely divided into two plates by the deep clefts of the posterior and anterior margins, only a narrow strip of sclerite joins the lateral lobes (fig. 123a); harpagones rather short and broad (fig. 123b).....(Guatemala) *distincta* n. sp., p. 385
   Vein R_{3+4} with an appendix near base; ninth tergum not so deeply cleft (fig. 122b); harpagones slender, more elongate (fig. 122a).....(Costa Rica) *appendicula* n. sp., p. 384
4. Cleft of ninth tergum broadly V-shaped, margins straight (fig. 125a).
   (Mexico) *mexicana* (Hardy), p. 387
   Cleft U-shaped, margins rounding..... 5
5. Harpagones slender, acutely pointed; posterior median margin of ninth sternum developed into a pair of strong lobes; sclerotized portion above aedeagus with a small niche in middle (fig. 127a).....(South America) *nigrita* Perty, p. 389
   Harpagones more broad, square tipped; posterior median margins of ninth not produced; sclerotized portion above aedeagus terminating in a small blunt point in the middle (fig. 124a).....(North America) *heteroptera* (Say), p. 386

Penthetria appendicula n. sp.

(Plate XXIX, figs. 122a-c)

This species differs from all known New World *Penthetria* in being more densely haired; vein R_{3+4} with an appendix at base; ninth tergum deeply cleft on hind margin and harpagones slender.

Entirely black, densely pilose species. Antennae eleven to twelve segmented, rostrum not greatly produced. Mesonotum rather thickly covered with long black hairs, scutellum bare or nearly so. Hum-

eral ridges very faintly yellowish tinged; propleurae each with a very dense patch of black hairs on upper portion; sternopleurae and hypopleurae thickly covered with long, thin hairs; sternopleurae finely rugulose and covered with fine yellow pubescence in addition to the long black hairs. All tarsi slender, posterior pair only slightly swollen, hind basitarsi almost equal in length to the next three subsegments of tarsi. *Wings:* Lightly yellow-brown fumose, vein R_{3+4} with a strong appendix at its base (fig. 122c); stigma slightly darker than the wing membrane; the third, fourth and fifth costal sections are about equal in length. Fork of first and second medial veins situated well beyond the r-m crossvein; base of M_{3+4} about half the length of the m-cu crossvein; cubital cell slightly narrowed in the wing margin by the downward curve of vein Cu_1. *Genitalia:* The ninth tergum is about twice as wide as long and deeply cleft, about two-thirds its length on hind margin (fig. 122b). Ninth sternum moderately concave in middle but with a membranous apex which makes the hind margin almost straight. Harpagones slender and rather elongate (fig. 122a).

Length: body, 8 mm.; wings, 9-9.4 mm.

FEMALE.—Aside from sexual characters the female differs in consistently having twelve segments in the antennae and the mesonotum less conspicuously haired.

Holotype male: Volcan Poas, Costa Rica, April 21, 1916 (A. Alfaro). Allotype female: La Carpentera, Costa Rica, April, 1924 (H. W. Atkinson). One paratype male, same data as holotype; two paratypes, one male, one female, same locality and date as allotype (W. M. Mann) and six paratype males, San Cristobal, Costa Rica, 5,400 ft., May 27, 1928 (F. G. Wallace).

Holotype, allotype and two paratypes returned to United States National Museum; three paratypes returned to the University of Minnesota, the rest retained in the Snow Entomological Collection.

Penthetria distincta n. sp.

(Plate XXIX, figs. 123a-b)

This species is related to *appendicula* Hardy but is distinguished by its dark fumose wings, lack of appendix at base of fourth vein, very deeply concave posterior and anterior margins of ninth tergum and shorter more broad harpagones; species not so thickly haired.

Antennae twelve segmented, wings brown fumose, stigma concolorous with the membrane; cubital cell widely open in wing margin, vein Cu_1 scarcely curved downward at its tip. All tarsi slender,

subsegments of hind tarsi but slightly swollen. *Male genitalia:* The ninth tergum is about twice as wide as long, densely haired and almost completely divided into two plates by the clefts of the anterior and posterior margins, only a narrow bridge of sclerite joins these two lateral plates (fig. 123a). The ninth sternum is moderately concave, the posterior lateral margins are rather strongly produced; these lobes are slightly undulated on outside margins. Harpagones broad, rounding apically (fig. 123b).

Length: body, 7-8.7 mm.; wings, 8-9.4 mm.

Female fits the above description except for sexual characters; the hind tarsi are, however, more slender, not at all swollen.

Holotype male: Antigua, Guatemala, June 24, 1923 (E. G. Smyth). Allotype female and five paratypes, four males, one female, same data as type (Smyth and D. G. Eisen); eleven paratype males, Guatemala City, Guat., May 2, 1923 (E. G. Smyth), two males, Agama, Guatemala (D. C. Eisen) and one male, Volcan Sta Maria, Guatemala (Schaus and Barnes).

Holotype, allotype and ten paratypes returned to the United States National Museum, others retained in Snow Entomological Collection.

Penthetria heteroptera (Say)

(Plate XXIX, figs. 124a-d)

Bibio heteroptera Say, 1823, Jour, Acad. Nat. Sci. Phil. III, 78.
Penthetria atra Macquart, 1834, Hist. Nat. des. Ins. vol. I, 175.
Eupeitenus ater Macquart, 1838, Dipt. Exot. Nouv. ou peu Connus. I, 85.
Plecia longipes Loew, 1858, Berl. Ent. Zeitsch. 2, 109-110.

E. ater Macquart was taken from a cabinet name of Serville but the original description was published by Macquart. There can be little doubt that this is the same genus and species which he had previously described as *Penthetria atra.*

P. heteroptera is distinguished from related species by the concave hind margin of the ninth tergum and the broad heavily sclerotized bridge behind the aedeagus.

MALE.—Opaque black, rather thickly black haired species. *Head:* Ocellar triangle very prominent; compound eyes divided into an upper and lower portion by a transverse depression near lower one-third to one-fourth of the eye. Antennae eleven segmented, including the knoblike tip segment. Rostrum not greatly produced, folded beneath the head in normal position. Mesonotum more sparsely haired, abdomen very densely pilose. Posterior femora and tibiae somewhat clavate, hind basitarsi slightly swollen and almost equal to next three subsegments of tarsi in length. Wings smoky brownish

to black, stigma black. The distance between the r-m crossvein and the fork of M_1 and M_2 is usually about equal to the length of Rs from r-m crossvein to fork of main branch of radius, these lengths may vary a good deal. Vein Cu_1 curved downward moderately toward its apex, somewhat narrowing the cubital cell. *Genitalia:* Thickly black pilose, ninth sternum cleft about one third its length on hind margin with a pair of moderate swellings medianly and a shallow broadly U-shaped cleft between these; these areas are developed into rather strong lobes in *nigrita* Perty. Harpagones slender and gently curved inward, somewhat square at apices, with a small acute point above. The genital chamber just above aedeagus is sclerotized and distinctive in shape, terminating in a blunt point medianly (fig. 124a). The ninth tergum is nearly twice as wide as long, with a broad U-shaped concavity on hind margin (fig. 124c).

Length: body and wings, 7-7.4 mm.

The female is more sparsely haired and specimens usually show more variation in wing venation. *Female genitalia*: The eighth sternum is completely divided into two plates by a narrow median membranous area, the posterior margin of these plates is developed into a large rounding lobe (fig. 124b). The hind margin of ninth tergum is straight or nearly so, the anterior margin is very deeply cleft so that only a very narrow strip of sclerite joins the two lateral lobes. Cerci elongated (fig. 124d); entire genitalia densely haired.

Type locality: Maryland.

Type probably lost.

This species is widely distributed in the Nearctic region north of Mexico; it has been identified from the following states and Canadian provinces: Colorado, Florida, Georgia, Iowa, Kansas, Louisiana, Maine, Manitoba, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New York, North Carolina, Ontario, Ohio, Pennsylvania, Quebec, South Carolina and South Dakota.

Penthetria mexicana (Hardy)

(Plate XXX, figs. 125a-b)

Plecia mexicanus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 199.

This species is related to *nigerrima* (Bellardi) and to *heteroptera* (Say), it is distinguished from the first by the broadly V-shaped cleft on the hind margin of ninth tergum (fig. 125a), and by the lack of development of the hind margin of ninth sternum. It is distinguished from *heteroptera* (Say) by shape of the sclerotized portion above the aedeagus and by the broadly rounding harpagones.

Antennae ten segmented in male, pleurae and sternum of thorax

reddish black in ground color, metanotum faintly tinged on the margins. Humeral ridges yellowish brown. In all specimens examined the cubital cell has been closed, or nearly so at its apex. The posterior tarsal subsegments are slightly swollen but not so much as in *nigerrima*. *Male genitalia:* Ninth tergum much wider than long, the V-shaped cleft extending one-fourth to one-third the length of the segment. Ninth sternum moderately concave medianly, hind margin without strong median lobes. Harpagones broad, gently curved and rounding apically (fig. 125b). Sclerotized portion above aedeagus shaped somewhat as in *nigerrima*.

Length: body, 7.2-7.6 mm.; wings, 7.4-7.8 mm.

Type locality: Guadalajara, Mexico.

Type in collection of H. J. Reinhard.

The writer has identified a series of toptoypes and specimens from Tamasopa, San Luis Potosi, Mexico, Dec. 4, 1909 (F. C. Bishopp).

Penthetria nigerrima (Bellardi)

(Plate XXX, figs. 126a-b)

Plecia nigerrima Bellardi, 1859, Saggio di Dit. Mes. I, 14-15.

Plecia costalis Walker (nec Wiedemann), 1858, Trans. Ent. Soc. Lond. V., 422. (Syn. by Edwards).

This species is related to *heteroptera* (Say) and is most conveniently separated by use of genital characters. The wings are most consistently yellow-brown fumose instead of blackish; the humeral ridges are usually yellowish tinged and the hind metatarsi more distinctly swollen, about equal in width to the tip of tibiae. The almost straight posterior margin of ninth tergum, the shape of the harpagones, ninth sternum and sclerotized portion above aedeagus will distinguish it.

Male genitalia: Ninth tergum wider than long, hind margin straight or nearly so (fig. 126b). Posterior median margin of ninth sternum developed into a pair of moderate lobes, harpagones broad and rounded apically. Sclerotized portion above aedeagus characteristically developed into a pair of slender lateral wings (fig. 126a).

The female genital structures compare with *heteroptera* (Say) except that the ninth tergum is divided into two lateral plates, not joined by a narrow strip of sclerite.

Length: body, 6.7-8 mm.; wings, 7.4-9.2 mm.

Type locality: Orizaba, Mexico.

Type at the Paris Museum.

The writer has studied topotypic specimens, also specimens from the following localities in Mexico: Mexico City (O. W. Barrett); Cuautla, June 3, 1922 (E. G. Smyth); Coapa D. F., Aug. 29, 1922 (E. G. Smyth); Hocomilco, April (W. M. Mann); Envir de Guadalajara, Estat de Jalisco, 1901 (M. Diguet); Cordoba, Dec. 17-Jan. 15, 1907-1908 (Fred'k. Knab).

Penthetria nigrita (Perty)

(Plate XXX, figs. 127a-b)

Penthetria nigrita Perty, 1830, Delectus Anim. Articularotum.

The description of *nigrita* is insufficient to positively identify the species, however, if Perty actually had a Penthetria before him there can be little doubt but that it was the common South American species.

Following is the original description:

"Aterrima, opaca; alis infuscatis, venis obscurioribus. Lg. 3'''. Latit. alar. expans. 10¼'''.

"Habitat in Provincia Piauhionsi.

"Magnitudine et statura *Penthetriae holosericeae* Meig. cui valde affinis videtur, quam vero ipsam non vidi. Toto atra, opaca, abdominis dorso parum nitidulo. Alae praesertim ad basin, ubi venae concurrunt, infuscatae, venis et membrana juxta vennae obscurioribus. Halteres et pedes atri."

This species is inseparable from the North American *heteroptera* (Say) except by genital characters and geographic distribution. The median lobes of the ninth sternum are more strongly produced, the median cleft more narrowly U-shaped and deeper and the harpagones are more slender and acute at their apices; the sclerotized portion behind the aedeagus has a small incision at apex (fig. 127a). The ninth tergum is wider than long with a broadly U-shaped concavity on hind margin, extending about one-third its length (fig. 127b).

Length of male: body, 7.4-8 mm.; wings, 9-9.4 mm.

Length of female: body, 8-8.7 mm.; wings, 7.4-10 mm.

Type located in the Zoölogical Museum at Munich.

The writer has identified this species from the following localities in South and Central America:

Bolivia: Germain (Lichtwardt).

Brazil: Sao Paulo.

Colombia: ac. 33501 (Felipe Ovalle Q.); Bogota, March 25-June 21, 1934-1937 (Apolinar, Bequaert, Peterson, Osorro); Quatiquia

R., Villavicencio, Nov.-Dec. 1914 (Dr. A. Balfour); Guarini (Peterson).

Ecuador: El Angel, 3000 ft., 1903 (P. Rivet); Minza Chica, V. Tungurahua, 3750 M., 2-14-IV, 1939 (F. M. Brown); Pichincha Prov., 3000 M., XI-5, 1938 (F. M. Brown); Uyambicho, XI-18, 1938, 2700 M. (F. M. Brown); Tungurahua, Banos 1600-1900 M. (W. M. MacIntyre).

Peru: Huacapistana, Rio Tarma, 1-2, June, 1920 (Cornell University Exp. Lot 569).

Venezuela: El Junquito, D. F. Jan. 15, 1939 (G. V. Berthier).

Plecia Wiedemann

Plecia Wiedemann, 1828, Aussereurop, Zweifl. Ins., 1, 72.
Rhinoplecia Bellardi, 1859, Mem. Roy. Ac. Sci. Torino (2), 19, 216.
Penthera Philippi, 1865, Verh. Zoöl.-Bot. Ges. Wien. 53, 603.

The species of this genus vary a great deal in color and size, from opaque black or cinereous to partially or chiefly shining rufous and from a body length of 2.1 mm. to 12.0 mm. Species usually rather sparsely haired on mesonotum and pleurae although some may be entirely covered with dense black pile. The rostrum, sclerotized portion of face below eyes, is short to greatly produced. In the subgenus *Rhinoplecia* the rostrum is developed about as long or longer than the length of the antennae. This character is considered of minor importance and several species such as *curvistylata* Hardy, *maura* Walker, and *seminitens* Edwards appear to be on the borderline between *Plecia* (Rhinoplecia) and *Plecia* (Plecia). The number of antennal segments varies from seven to twelve, the females often having one more segment than the males. The legs are slender, elongate, usually black and thickly haired. Wings hyaline to blackish fumose, the radial sector forks beyond the radio-medial crossvein, the anterior branch (R_{3+4}) is short and rather vertical in position. The best specific characters are found in the male genital structures. The shapes of the ninth tergum and sternum are distinctive. The female genitalia also show specific characters but just how diagnostic these are has not been thoroughly worked out; this is the first comparative study of the female structures that has been made.

This genus is allied to *Crapitula* and *Penthetria* but is distinguished by the wing venation and the position of the male harpagones. The short, almost vertical vein R_{3+4} and the more vertical harpagones will separate *Plecia;* the ninth segment and genital appendages show much greater differentiation than in the related genera.

While studying the *Plecia* the writer has examined large numbers of specimens from many geographical regions in South, Central and North America which fit perfectly the original descriptions of several apparently well founded species. These have always been placed with a query because of the noticeable generality of their definition and the wide geographical range over which they extend. The most notable in this group are *Plecia confusa* Loew, *P. rufithorax* Walker, *P. bicolor* Bellardi and *P. collaris* Fabr. *Plecia confusa* Loew was long known as *P. ruficollis* Fabr., Wiedemann identified specimens as this from Brazil. A few years later H. Loew stated that it was very unlikely that the South American species could be the same as that from Africa and proposed the name *confusa* for it. Since that time this name has been used to indicate those specimens having a short rostrum and the thorax entirely rufous, even including the North American specimens under this name. Study of the male genital structures through this series proved that it is actually a complex of many species; this has also proved to be the case in the *rufithorax*, *bicolor* and *collaris* groups. These important structures have received but little attention in the *Plecia* and this accounts for the "lumping" of well defined species.

The genus is almost world wide in distribution although the larger share of species are confined to the tropical regions. Only two *Plecia* (*americana* Hardy and *nearctica* Hardy) are known from America north of Mexico.

Genotype: *Hirtea fulvicollis* Fab., 1828, Auss. Zweifl. Ins. 1, 72.

KEY TO PLECIA

(Based largely upon males)

1. Thorax polished, at least on the dorsum, sometimes with three to four shining vittae, or dorsum rufous and pleurae black 2
   Thorax subopaque to gray dusted, if subshining the notum is at least lightly pruinose, pleurae usually concolorous with dorsum 12
2. Mesonotum with three to four shining stripes which are distinctly separated by opaque or dusted longitudinal lines, usually black species 3
   Mesonotum not divided into stripes by opaque lines, usually at least in part rufous, 9
3. Wings smoky with a conspicuous pale yellow fascia across the middle; ninth sternum of male genitalia very large and extending around to the dorsal portion of the segment ..... 3a *pictipennis* Edwards, p. 426
   Wings uniformly fumose or chiefly hyaline, ninth sternum not so developed 4
   3a. Stripes of mesonotum shining black ..... *pictipennis pictipennis* Edwards, p. 426
   Shining stripes of mesonotum reddish ..... *pictipennis rufovittata* Edwards, p. 427
4. Harpagones of male genitalia not bilobed 6
   Harpagones bilobed 5
5. Inner (lower) lobe of each harpago much smaller than outer and below it (fig. 160a). Harpagones slender from lateral view with only one lobe visible (fig. 160b); sternum with a U-shaped median cleft; median process of ninth tergum projected beyond posterior margin of segment ..... *persimilis* Hardy, p. 424
   Inner lobe projecting on the same level or above outer, almost as strong; sternum with

a broad flat topped median development (fig. 174a). Harpagones broad from lateral view, both lobes visible (fig. 174b). Median process of tergum not so developed.
seminitens Edwards, p. 437

6. Three longitudinal stripes on mesonotum, middle stripe undivided; ninth tergum not cleft on hind margin (fig. 155a); harpagones broad.....*nitidicollis* Edwards, p. 420
Four stripes on mesonotum, median stripe divided by a thin gray line; harpagones more narrow 7
7. Rostrum developed twice as long as the antennae, much longer than the head; ninth tergum of male cleft almost half its length (fig. 166d).
(Mexico) *quadrivittata* Williston, p. 430
Rostrum little if any longer than the antennae; ninth tergum only slightly concave on hind margin and with a median process..... 8
8. Ninth tergum of male with a pointed median process, posterior lateral margins narrow (fig. 165a); harpagones long and slender (fig. 165b). (Some males of this species may run here, all females observed have been entirely opaque)..*punctulata* Hardy, p. 429
Ninth tergum with a broad square topped median process, margins not produced (fig. 130d). Harpagones with a long, slender, inward projecting beak as seen from lateral view (fig. 130c).....*avicephaliforma* Hardy, p. 396
9. Dorsum of males chiefly shining black, thorax of females rufous; small species (body 2.1-3.5 mm.; wing 2.6-4 mm.) 10
Sexes not dimorphic, at least the dorsum chiefly rufous, larger species..... 25
10. Mesonotum finely shagreened, ninth sternum of male with a pair of blunt processes on posterior margin .....*rugosa* Hardy, p. 436
Not possessing the above characters, very minute species..... 11
11. Ninth tergum of males deeply cleft, dorsum of male entirely black, *edwardsi* Hardy, p. 408
Ninth tergum but slightly concave, margins of mesonotum of male rufescent.
rufimarginata Hardy, p. 433
12. At least posterior half of mesonotum yellow to rufous..... 39
Thorax chiefly black in ground color, at least on dorsum (*marginata* Edwards has a narrow border of orange on mesonotum and reddish pleurae and abdomen).....13
13. Thorax distinctly gray pruinose..... 14
Thorax subopaque to dull black, not distinctly grayed.....16
14. Ninth sternum of male developed into two long armlike processes on hind margin, harpagones median in position (fig. 164a).....*pruinosa* Hardy, p. 428
Not so developed 15
15. Ninth sternum concave in middle on hind margin, posterior lateral margins not developed (fig. 148a) .....*lateralis* Hardy, p. 413
Ninth sternum with a median development, posterior lateral margins produced (fig. 144a) .....*grisea* Edwards, p. 410
16. Wings yellow-brown to black fumose along the veins, hyaline in the middle of the cells 17
Wings more evenly fumose, not contrasting hyaline in middle of cells..... 18
17. Scutellum black, ninth tergum of male deeply excavated on posterior margin (fig. 163b), lobes of posterior lateral margins of sternum rounded (fig. 163a).
plagiata Wiedemann, p. 427
Scutellum bright orange, ninth tergum deeply excavated on anterior margin only gently concave on posterior margin (fig. 170a); posterior lateral margins of sternum square tipped (fig. 170b) .....*rufiscutella* Hardy, p. 433
18. Head and body rather thickly black haired; ninth sternum very irregular on hind margin, with three pairs of lobes besides a median moundlike development, median pair of lobes finely toothed on inner margins (fig. 154c).....*nigra* (Philippi), p. 419
Species not so hairy, hypopygium different..... 19
19. Small species, length of wing 4.3-5.3 mm.; ninth tergum produced on posterior median and lateral margins (fig. 165a); entire notum minutely punctulated.
punctulata Hardy, p. 429
Larger species, not as above 20
20. Wings pale, yellowish to gray 21
Wings chiefly brown to black fumose..... 22
21. Mesonotum black, except around margins; pleurae and abdomen reddish.
marginata Edwards, p. 417
Entirely black, face scarcely produced below eyes, hind margin of ninth sternum with two pairs of well developed lobes (fig. 156a). Ninth tergum with a sharp triangular process in middle on hind margin (fig. 156b).....*nitidipes* Edwards, p. 421

22. Costal margin sharply contrasting with the rest of wing 23
Costal margin for the most part concolorous with rest of wing, or but slightly darker 24
23. Costal margin bright yellow ..... *costalis* Wiedemann, p. 404
Costal margin black ..... *imperialis* Schiner, p. 411
24. Humeral ridges, scutellum and margins of ninth sternum strongly produced (fig. 146a) ..... *impilosa* Hardy, p. 412
Entirely black species, posterior lateral margins of sternum not produced (fig. 152a). *maura* Walker, p. 417
25. Entire thorax yellow to rufous; ninth tergum of male with a slitlike invagination in middle on hind margin (fig. 140c) ..... *ecuadorensis micans* Hardy, p. 407
Dorsum of thorax chiefly rufous, pleurae entirely black; tergum of male without narrow slitlike invagination 26
26. Anterior portion of notum with a conspicuous black or dark brown area. (collaris group) 27
Entire dorsum rufous (bicolor group) 30
27. Ninth sternum with a pair of median processes on hind margin, with a small U-shaped cleft between; harpagones two lobed as seen from lateral view (fig. 133c), ninth tergum with a blunt process in middle (Brazil, Paraguay, Bolivia, Panama). *collaris* Fabricius, p. 401
Without the above combination of characters 28
28. Ninth sternum with a large, blunt median development on hind margin, ninth tergum without median process 29
Ninth sternum gently concave on posterior margin (fig. 134b), ninth tergum with a blunt median lobe (fig. 134c) ..... (Brazil) *brazilana* Hardy, p. 400
29. Harpagones large and obtuse, ninth sternum extending greatly beyond bases of harpagones (fig. 149a). (Atypical specimens may run here) .. (Brazil) *lindneri* Edwards, p. 414
Harpagones rather small, narrowly pointed; ninth sternum not greatly developed (fig. 178a) ..... (Honduras, Mexico) *uberta* Hardy, p. 441
30. Posterior margin of ninth tergum developed into two long arms which extend inward toward the genital chamber (fig. 132c). Harpagones each with two strong sharp teethlike developments on inner side (fig. 132a) ..... (Mexico) *bicolor* Bellardi, p. 398
Not with the above characters 31
31. Harpagones simple, without secondary lobes 32
Harpagones with two or three lobes 37
32. Aedeagus with a pair of accessory lobes which project outward from above the ninth sternum, very conspicuous from ventral view (fig. 159c) .. (Cuba) *perplexa* Hardy, p. 423
Without such developments 33
33. Posterior median margin of ninth sternum strongly developed, harpagones slender but blunt (fig. 139a) ..... (Colombia) *disparis* Hardy, p. 406
Not as above 34
34. Ninth sternum with an acute median process (fig. 150b) .... (Brazil) *lopesi* Hardy, p. 415
Without median process 35
35. Posterior median margin of ninth sternum with two pointed lobes, harpagones serrate on inner margins as seen from ventral view (fig. 175a) ..... *serrata* Hardy, p. 438
Not with these characters 36
36. Harpagones slender and sharply curved inward (from lateral view) (fig. 137b), posterior margin of ninth tergum gently concave (fig. 137d), small species. (Mexico) *curvistylata* Hardy, p. 405
Harpagones broad and stout (fig. 180a), only a small concavity on posterior margin. (Brazil) *vittata* Wiedemann, p. 442
37. Harpagones with only two lobes 38
Harpagones with three lobes as seen from a lateral view (fig. 177b). (British Guiana) *trilobata* Hardy, p. 440
38. Only one arm of the harpago visible from ventral view, ninth sternum not developed on posterior lateral margins (fig. 153) .. (Mexico, North America) *nearctica* Hardy, p. 418
Both lobes visible from ventral view, posterior lateral margins produced (fig. 131a). (Costa Rica) *biarmata* Hardy, p. 397
39. Thorax entirely yellow to rufous 40
Pleurae and anterior portion of notum black ..... *lindneri* Edwards, p. 414

40. Ninth tergum greatly developed into two large clasperlike lobes; tergum almost completely divided in middle (fig. 136c). Rostrum short.....*confusa* Loew, p. 402
Tergum not so developed; rostrum usually longer than the head..... 41
41. Ninth tergum with a distinct slitlike invagination in the middle on posterior margin, inner margins almost contiguous (fig. 140c)..... 42
Inner margins distinctly separated or without such an invagination..... 43
42. Posterior median margin of ninth sternum with a strong toothlike process; harpagones rather simple (fig. 140a).....*ecuadorensis* Hardy, p. 406
No such sharply pointed process in the middle of ninth sternum; harpagones greatly developed, very irregular in shape (fig. 181d).....*xenia* Hardy, p. 443
43. Posterior median margin of ninth sternum with one or more distinct processes or developments, at least with a moundlike gibbosity in middle..... 44
Without such developments 55
44. With two such processes, sometimes a somewhat membranous development between these 45
With only one median process or with a moundlike, sometimes membranous, swelling in middle 48
45. Two long armlike developments from middle of ninth sternum (fig. 157c); only a small V-shaped excavation on posterior margin of ninth tergum (fig. 157b).
panamaensis Hardy, p. 422
Median processes not so developed 46
46. Ninth tergum deeply cleft, more than half its length; median processes of sternum not divided apically, harpagones more narrowly pointed..... 47
Ninth tergum gently concave, cleft less than half its length (fig. 133b); median processes divided apically, harpagones more blunt apically.....*biformis* Hardy, p. 399
47. Cleft of tergum broad (fig. 147c); harpagones narrow, posterior lateral margins of sternum developed into clublike processes (fig. 147a).....*incurvata* Hardy, p. 413
Cleft narrow (fig. 151d); harpagones more broad, posterior lateral margins not so developed (fig. 151a) .....*maculata* Hardy, p. 416
48. Harpagones bilobed (fig. 128c); ninth tergum with a V-shaped indentation on hind margin, anterior margin of segment greatly excavated (fig. 128d)....*alacris* Curran, p. 395
Harpagones without a secondary lobe..... 49
49. Ninth tergum with only a small V-shaped cleft in middle on hind margin, or with but a slight indentation 50
Tergum moderately concave to angulate on hind margin..... 51
50. Ninth sternum deeply cleft, harpagones small (fig. 129d).....*americana* Hardy, p. 395
Sterna produced into a clavate process in middle, harpagones rather large and irregular (fig. 179a) .....*varabilis* Hardy, p. 441
51. Median process of ninth sternum blunt and rounding apically, somewhat membranous 52
Median process developed into two prominences apically, with a median depression, the process may be quadrate in outline 51a.....*rufithorax* Walker, p. 434
51a. Tergum gently concave on posterior margin (fig. 172d).
rufithorax concava Hardy, p. 435
Cleft of tergum with almost straight sides, scarcely rounded (fig. 171b).
rufithorax rufithorax Walker, p. 434
52. Tergum with a strong pointed process in middle on hind margin (fig. 161b), harpagones small (fig. 161a).....*pertinens* Hardy, p. 425
Tergum without such a development..... 53
53. Bottom of cleft on hind margin of tergum straight (fig. 167c).....*rectiora* Hardy, p. 431
Bottom concave or with small convexity in center..... 54
54. Tergum with a slight convexity in the middle of the broad concavity (fig. 143d); harpagones rather narrowly pointed (fig. 143e).....*gibbosa* Hardy, p. 409
Without such a median convexity (fig. 168d); harpagones not so sharply pointed (fig. 168c) .....*rostellata* Loew, p. 432
55. Ninth tergum moderately cleft 56
Never more than small V-shaped cleft on hind margin of tergum, or without cleft, 58
56. Tergum with a prominent median process on hind margin; harpagones small..... 57
Tergum without such a development, cleft broad and flat bottomed, *rectiora* Hardy, p. 431
57. Tergum with a more U-shaped concavity, median process well developed and stout (fig. 161b); bases of harpagones as wide as lobe of posterior lateral margin of ninth sternum (fig. 161a) ..... *pertinens* Hardy, p. 425

Hind margin of tergum more V-shaped, median process smaller, more spinelike (fig. 158b); harpagones very small (fig. 158a).....*parvistylata* Hardy, p. 423

58. Sternum cleft on hind margin..... 59
Sternum broadly convex on hind margin, harpagones very irregular (atypical specimens may run here).....*xenia* Hardy, p. 443

59. Tergum with a small V-shaped indentation (fig. 129c); sternum cleft almost one-half its length (fig. 129d) (some atypical specimens of this species run out here).
americana Hardy, p. 395
Tergum developed into a slight triangular point medianly (fig. 138d); ninth sternum with a small median cleft (fig. 138c).....*dentata* Hardy, p. 405

Plecia (*Plecia*) *alacris* Curran

(Plate XXX, figs. 128a-d)

Plecia alacris Curran, 1934, Bull. Amer. Mus. Nat. Hist. LXVI, 310, 311.

MALE.—*Head:* Rostrum shorter than the head and scarcely visible except from underneath. *Thorax:* Entirely yellow-orange on the mesonotum, pleurae slightly darker with a few indistinct brownish markings. Legs and abdomen black with black hair. *Wings:* Brownish yellow fumose, costal cell and stigma slightly darker, veins brown. Humeral crossvein and branch of radial sector (vein R_{3+4}) oblique, slanting straight into the costa (fig. 128a). The fork of the veins M_1 and $_2$ situated before basal one-third of the distance from the radio-medial crossvein to the fork of the radial sector and before the end of the subcosta. Vein R_{1+2} runs somewhat parallel with the costa through the stigmal area. Halteres with black knobs, stems pale. *Genitalia:* Ninth sternum very short in proportion to its width, almost twice as wide as long, slightly longer on the lateral margins; posterior median margin of segment with a large blunt development (fig. 128b). Harpagones appearing simple from ventral view, only one rather acutely pointed lobe visible. From a lateral view a second, lower lobe is visible; this lobe is strong, toothlike and projects inward (fig. 128c). Ninth tergum with a small V-shaped excavation on the hind margin and another deeper concavity on the anterior margin, the two median points almost dividing the segment into two parts (fig. 128d).

Length: body, 6-6.5 mm.; wing, 6.5 mm.

Female unknown.

Described from British Guiana, type in American Museum.

The writer has examined a paratype male, also one male from Paraguay.

Plecia (*Plecia*) *americana* Hardy

(Plate XXX, figs. 129a-d)

Plecia americana Hardy, 1940, Journ. Kan. Ent. Soc. 13; 15-16.

This species is related to *confusa* Loew but is of smaller size, the antennal segments are more compacted and the development of the

ninth sternum and tergum will distinguish it. Following is the original description of the male hypopygium:

"*Male genitalia:* Ninth sternum deeply concave on posterior margin, cleft about one-half the length of the segment, with a membranous mound in the middle; posterior lateral margins moderately produced; harpagones very small (fig. 129d). Ninth tergum broad, with a small V-shaped excision in the middle on the hind margin (fig. 129c)."

Male length: body, 4.5-5.3 mm.; wings, 5-6 mm.

Female genitalia: The eighth sternum is developed into a pair of strong, heavily sclerotized lobes joined by a comparatively narrow bridge medianly at the anterior portion of the segment (fig. 129a). Ninth tergum narrow, about one-fourth as long as wide, on lateral margins; posterior margin almost straight, very slightly concave. Cerci large and round, densely covered with strong bristles and hairs (fig. 129b). Lateral margins of ninth tergum greatly developed and curved inward giving support to the walls of the genital chamber.

Length: body, 5-6 mm.; wings, 7 mm.

Type locality: Florida.

Type in the United States National Museum collection.

This species is known also from Georgia, Mexico, North Carolina, South Carolina, Texas and Alabama.

Plecia (*Rhinoplecia*) *avicephaliforma* Hardy

(Plate XXX, figs. 130a-d)

Plecia avicephaliforma Hardy, 1940, Journ. Kan. Ent. Soc. 13; 16.

Following is the original description:

"This species is related to *quadrivittata* Williston in having four shining stripes down the mesonotum, the median stripe being divided by a narrow gray line. It differs from this species in having the rostrum shorter than the head; the scutellum opaque (shining in *quadrivittata*); vein R_{2+3} (R_{3+4}) curved or bowed before entering the costa. The male genitalia is very distinctive, as is pointed out in the description; the specimens are also slightly smaller.

"*Male.*—Entire black species. *Head:* Antennae nine segmented, the segments short and compressed; rostrum about equal to the antennae in length, shorter than the head. *Thorax:* Opaque, lightly pruinose, except for shining stripes on dorsum; upper portions of sternopleurae with sparse brownish hairs, mesonotal furrows and margins of notum with scattered yellowish hairs. Legs and abdo-

men with brown to black pile. *Wings:* Brownish fumose, veins dark brown, stigma but slightly darker than membrane; vein R_1 ends at about two thirds the distance from end of subcosta and R_{2+3} (R_{3+4}), vein R_{2+3} (R_{3+4}) strongly curved into the costa (fig. 130a). Radiomedial crossvein situated at about the middle of the distance from the m-cu crossvein and the fork of media.

"*Male genitalia:* Sternum rather broad, developed apically into two pairs of small lobes, the lateral pair larger more rounding, the median pair small, sometimes scarcely divided and simulating a single development (fig. 130b). Harpagones simple, with a long beaklike tooth projecting inwardly (avicephaliform) as seen from a lateral view (fig. 130c); scarcely visible from ventral view. Tergum gently concave with a broad flat topped development medianly (fig. 130d).

"Length: body, 3.3-3.7 mm.; wings, 4 mm.

"Female unknown."

Type locality: Diamantina, Minas Geraes, Brazil.

Type in Cornell University Collection.

Plecia (*Rhinoplecia*) *biarmata* Hardy

(Plate XXX, figs. 131a-b)

Plecia (*Rhinoplecia*) *biarmata* Hardy, 1942, Can. Ento. LXXIV, 105-106.

"This species is related to *bicolor* Bellardi and cannot be separated from that species without use of the male genitalia. The fork of the Rs arises at the end of vein R_{1+2}; R_{3+4} arises vertically for a short distance than slants gradually into the costa in the male, more obliquely in female. These characters may be variable and would not present a convenient means of separation.

"Male Genitalia: The genitalia of this species are extremely diversified, the ninth sternum is very broad, with a medial projection which is concave on its posterior margin. The claspers are large and divided into two well developed lobes visible from above; the outer arms being more stoutly developed (fig. 131b). The ninth tergum is gently concave on its posterior margin (fig. 131a).

"In the female the metapleurae, hypopleurae, ptero and propleurae are rufescent tinged; the antennae are eleven segmented, with the segments rather compressed.

"Length: male, body, 4.5 mm.; wings, 4.7-5 mm.

"Female, body 5 mm.; wings, 6-6.5 mm."

Type locality: Crontena, Costa Rica.

Type in Cornell University collection.

Plecia (Rhinoplecia) bicolor Bellardi

(Plate XXX, figs. 132a-e)

Plecia bicolor Bellardi, 1859, Saggio di Ditterologia Messicana, pt. 1, 16.

MALE.—*Head:* Rostrum developed to form a beak, longer than the head and extending backward beneath the face. Antennae nine segmented, brown to black with a slight yellowish tinge at the base of the segments; segment three equal to the first two in length, other segments more nearly equal. Ocellar tubercle very prominent, as is the case in most species of this genus. Compound eyes divided into upper and lower portions by a slight indentation of the lower third or fourth. *Thorax:* Dorsum bright orange, with three longitudinal grooves which converge slightly before the scutellum. Pleurae velvety brown to black. Halteres brownish black. *Legs:* Slender, brownish black with dense, short black hair. All femora and posterior tibiae straight or nearly so. Basitarsi about equal in length to the next three tarsal subsegments, pulvilli yellow. *Wings:* Brownish yellow fumose, costal cell brown, stigma not noticeably differentiated. Fork of third vein arising before the end of second vein, slanting rather sharply toward the costa. Fork of the fourth vein but little before the middle of the base of vein M_{3+4} and fork of the third vein. Cubital cell widely open. *Abdomen:* Subopaque brownish black with dense dark hairs. *Genitalia:* Ninth sternum narrowing posteriorly with a rounding concavity on the posterior margin (fig. 132b). Claspers very broad and irregularly toothed on the inner margin, two large sharp pointed teeth above and several below as seen from a lateral view (fig. 132a). The claspers are folded down in their normal position so they are somewhat difficult to see from a ventral view. Ninth tergum developed on its hind margin into two long armlike projections, these fold toward the genital chamber in their normal position so the tergum must be tilted up slightly to see them (fig. 132c).

Length: body, 4 mm.; wing, 4.5 mm.

FEMALE.—Other than in the secondary sexual characters and slightly larger size the female does not differ a great deal from the male. *Genitalia:* Eighth sternum produced into two pairs of strong posterior lobes, the outer lobes are rounded apically, the inner pair are elongated, slender and greatly curved outwardly; these processes arise from the upper portion of the sternum. The eighth sternum is deeply cleft medianly with only a narrow strip of sclerite joining the two plates at their bases. This cleft broadens posteriorly and the margins are straight (fig. 132e). Ninth tergum deeply U-shaped

on hind margin, this cleft extends three fourths the length of the tergum. The cerci are elongated and slender (fig. 132d).

Length: body, 5 mm.; wing, 6.3 mm.

Type located at University of Turin.

Specimens examined from the type locality of the species, Cordova (Cordoba) and Orizaba, Mexico (Frederick Knab), also Teapa, Tabasco, Mex., Jan., 1903, and Barro Colorado Isld., Canal Zone, Feb. 18, 1929 (C. H. Curran).

Plecia (Rhinoplecia) biformis Hardy

(Plate XXXI, figs. 133a-d)

Plecia (Rhinoplecia) biformis Hardy, 1942, Can. Ento. LXXIV, 106.

"This species is related to *rufithorax* Walker by having the thorax entirely rufous and the rostrum produced longer than the length of the antennae. The genitalia also show relationship but the specific characters are very pronounced in both sexes.

"*Male genitalia:* The posterior lateral margins of the ninth sternum are not produced and the hind median margin is developed into two prominent lobes, each is divided at its apex, a V-shaped cleft separates the two developments (fig. 133a); the sternum is slightly grooved longitudinally down the middle. The harpagones are strongly produced on upper apical edges and each is developed into a sharp pointed tooth below. The upper lobe is much larger, more obtuse while the lower is smaller more acute, instead of the lower portion of the apex being the more strongly developed as in *rufithorax*. The ninth tergum is much shorter than the sternum and rather deeply concave on posterior margin, posterior lateral margins rather acutely pointed, not so rounding as in *rufithorax*. The bottom of the cleft has a slight membranous portion and the margins are covered with dense short hair (fig. 133b).

"Length: body, 4.5-5 mm.; wing, 5.5 mm.

"*Female genitalia:* The eighth sternum is developed into a pair of median lobes on hind margin, with a deeply V-shaped cleft between; this cleft extends nearly half the length of the segment. Posterior lateral margins broadly rounding, covered with dense fine hairs on the sides; the sternum is almost twice as wide as long (fig. 133c) and differs from *rufithorax* in the development of the posterior margin. The ninth tergum has a broad troughlike cleft extending half the length of the segment, the lateral lobes are rather square-topped (more undulated in *rufithorax*) and are densely covered with fine hair. Cerci broad and rounding (fig. 133d).

"Length: body, 7 mm.; wing, 7.5-8 mm."
Type locality: Trinidad.
Type in the Snow Entomological Collection.

Plecia (Rhinoplecia) brazilana Hardy

(Plate XXXI, figs. 134a-c)

Plecia (Rhinoplecia) brazilana Hardy, 1942, Can. Ento. LXXIV, 106-107.

"This species is related to *collaris* Fab. by having the anterior portion of the dorsum blackish. It is distinguished from other species in this complex by having the posterior margin of the ninth sternum concave and by the blunt median lobe of the ninth tergum.

"MALE.—*Head:* Rostrum greatly produced, almost twice as long as head and about three times as long as the antennae. Antennae yellow-brown to dark brownish, composed of nine segments. Compound eyes divided by a transverse groove at about lower one-third. *Thorax:* Dorsum rufous with a dark brown to black discoloration on the anterior portion in the middle, pleurae reddish brown to black, muck darker in color than the dorsum. Sternopleurae shining on the lower halves, pleurae otherwise subopaque. Stems of halteres reddish to slightly brownish, knobs brown. *Legs:* Bases of femora yellowish, verging into rufiscent brown apically, legs otherwise brown to black; pile short, dense and black. Basitarsi about equal to the next three subsegments in length. *Wings:* Brownish fumose, anterior branch of radial sector (R_{3+4}) arising slightly beyond the end of R_{1+2} and extending almost vertically into the costa. Fork of media arising at about one third the distance between the r-m crossvein and the fork of the Rs. Cubital cell widely opened (fig. 134a). *Abdomen:* Faintly shining on the venter, opaque above. *Genitalia:* Ninth sternum rather broad with a moderate concavity on the posterior border in the middle, developed into a heavily sclerotized point on each posterior lateral margin. Claspers simple, bluntly pointed and slightly curved outward (fig. 134b). Ninth tergum somewhat divided into two portions by a V-shaped groove in the middle on the posterior margin, out of which arises a blunt, almost square-topped development (fig. 134c).

Length: body, 3.8-4 mm.; wing, 4.6-4.8 mm.

"FEMALE.—Differs in having the rostrum even more elongate, the femora are more yellow basically, R_{3+4} arises vertically for a very short distance, then slants obliquely into the costa. Antennae eleven-segmented.

"Length: body, 4.3 mm.; wings, 5.4 mm."

Type locality: West Border, Matto Grosso, Brazil.
Type in United States National Museum.

Plecia (*Rhinoplecia*) *collaris* (Fabricius)

(Plate XXXI, figs. 135a-e)

Hirtea collaris Fabricius, 1805, Syst. Ant. 54.

The type of this species has apparently been lost and the species is unindentifiable from the original description. The common South and Central American species of the *collaris* group is no doubt what Fabricius had before him; this is described here.

The complexity of the male harpagones and development of the ninth sternum makes this species easy to recognize. The black spot on the dorsum of the thorax is also more extensive than in other members of the group.

MALE.—*Head:* Rostrum developed longer than the antennae and folded beneath the face. Antennae eight segmented, scape yellow, other segments black. *Thorax:* Mesonotum bright orange with a large dark brown to black spot covering the anterior one-third of the dorsum. Humeral ridges yellowish. Pleurae brownish, tinged with rufous. Stems of halteres reddish, knobs brown. Legs and abdomen brown to black. *Wings:* Yellowish fumose, slightly brown costally, veins and stigma brown. Vein R_{3+4} (fork of third vein) arising beyond end of R_{1+2}, the lower one-half of the vein vertical, the apical portion slanting rather abruptly into the costa. Fork of M_1 and $_2$ at about one-third the distance from basal portion of M_{3+4} to the fork of the Rs. *Genitalia:* Ninth sternum slightly wider at bottom, gradually slanting toward the apex, terminating in a bilobed projection. Harpagones very broad and irregular; seen from above as a stout dorsal development, and a basal, slightly pointed process (fig. 135e). From a lateral view the claspers appear to be bilobed (fig. 135c), the upper lobe more broad and beaklike, the lower produced laterally, pointing dorsally in its normal position. Ninth tergum gently concave with a projection in the center, this in turn having a small concavity (somewhat V-shaped) on its posterior edge (fig. 135d).

Length: body, 5.5-6.5 mm.; wings, 6-6.5 mm.

FEMALE.—Antennae ten segmented, rostrum slightly longer, otherwise like the male except for sexual differences. *Genitalia:* The ninth tergum is broadly U-shaped on posterior margin, posterior lateral margins rounding (fig. 135a). Cerci thickly haired and elongated in shape. The eighth sternum is abnormally developed,

not completely divided medianly, with a narrow sclerite joining the two plates near the base of segment. The sternum is produced into a pair of strong, obtuse lobes near median portion on hind margin and another pair of acutely pointed lobes just below these on their inner margins, another strong process extends in toward the genital chamber, this structure is attached to the upper portion of the eighth sternum on top side (fig. 135b).

Length: body, 5-7.5 mm.; wing, 7-8 mm.

Type locality given as "America meridionali."

Present location of type unknown by this writer.

The writer has identified the species from the following localities:

Argentina: Posados, Missiones Terr. 13-15, i, 1927—63 (F. and M. Edwards); B. Aires—Tigre, I, 1938 (F. Schade).

Bolivia: Rosario Lake, Rogague, Oct. 28-Nov. 9, 1921 (W. M. Mann, Mulford Biol. Expl.).

Brazil: Sao Paulo, Oct. 16, 1934 (L. T. F.); Santa Maria, State of Rio Grande do sul (T. White); Corumba, Matto Grosso, Dec. 14-23, 1919 (R. G. Marris); Brasilien Nova Teutonia, 27° 11′ B. 52° 23′ (F. Plaumann).

Colombia: Bet. Queremal and Buenaventura, alt. 3,500-4,000 ft., Feb. 12, 1935 (H. F. Schwarz); Cali District, Cauca Valley, alt. 3,260 ft., Feb. 20, 1935 (H. F. Schwarz); Popayan, alt. 6,800 ft., Feb. 15, 1935 (E. I. Huntington and H. F. Schwarz); Medellin (H. Daniel).

Honduras: Subirana Yoro, Dec. 21, 1932 (Stadelmann).

Panama: Patilla Pt. Can. Zone, Jan. 15, 1939 (C. H. Curran); Porto Bello, Feb. 15, 1911 (E. A. Schwarz).

Paraguay: Accession numbers 5 and 182 (Zurcher leg.) Tacuru-Pucu, 2-7 Apr. (D. Wees); Villarica, X, 1936 (F. Schade).

Plecia (*Plecia*) *confusa* Loew

(Plate XXXI, figs. 136a-d)

Plecia confusa Loew, 1858, Berl. Ent. Zeit. 11, 109.

This is a change of name for *P. ruficollis* Fabricius, 1805, Systema Antiliatorum, p. 53 (Middle America); as distinguished from *Plecia ruficollis* Fabricius, 1781, Species Insectorum Vol. 2, 410 (Cape of Good Hope).

Loew's type of *confusa* has apparently been lost, as it was not to be located in the European Museums, so it has been necessary to erect Wiedemann's specimen from Bahia, Brazil, as a neotype. Wiedemann determined this species as *ruficollis* Fabr. and Loew

later changed the name. This species has been studied by the late Doctor Edwards and drawings of the male genitalia sent to the writer. This proved to be identical with a Brasilian *Plecia* already at hand. This species is larger in size than any other in this complex, known to the writer, and it is unique in the development of the male genitalia.

MALE.—*Head:* Rostrum short, less than one-half the length of head. Palpi four segmented, the segments long and slender. Antennae ten segmented, counting the distinct apical tip; the first segment of flagellum about twice as long as wide, other segments rounding, slightly oblong. *Thorax:* Entirely deep yellow to orange. Mesonotum with two longitudinal furrows which converge slightly before the scutellum; lateral mesonotal slopes flat, and a slightly concave area present just behind the humeral ridges. Sternopleurae with a sparse patch of short brown to black hairs just above middles, thorax otherwise chiefly bare. Knobs of halteres brown, stems pale. Legs and abdomen dark brown to black with dense black hair. Femora thickened apically, tibiae straight or nearly so; basitarsi equal to scarcely longer than succeeding three tarsal subsegments. *Wings:* Yellow-brown fumose, costal cell and stigma more browned; vein R_{1+2} ending but slightly before the end of R_{3+4}; anterior branch of radial sector (vein R_{3+4}) oblique with a slight curve toward its base (fig. 136d). Fork of M_1 and$_2$ at basal one-third of the distance between the r-m crossvein and the fork of the Rs. *Genitalia:* Ninth sternum much wider than long; posterior lateral margins developed into strong, hairy clasperlike lobes; hind margin slightly undulated in the middle, otherwise almost straight (fig. 136a). Two unmounted specimens show minute teethlike bumps on the inner edges of the lobes, these are not visible on genitalia mounted on a slide and are probably obscured by the flattening out of the structure. Cerci slender, spinose and much longer on inner margin.

Length: body, 7.5-9 mm.; wing, 8.5.-9.5 mm.

FEMALE.—The antennae are slightly longer and eleven segmented, including nipplelike tip which is not so pronounced as in the male; palpi yellow-brown, about as long as the antennae. Otherwise like the male, except for shorter body and longer wings.

Length: body, 6-7 mm.; wing, 11-12 mm.

Neotype locality: Bahia, Brazil.

Neotype at Vienna.

Specimens have been examined from Rio Colorado, Bolivia, Sept.

1921-22 (Mulford Bio.-Expl.); Boa Vista Tapajos, Para. (Townsend); Barro Colo. Isld., Canal Zone, II, 13, 1929 (C. H. Curran); Bet. Queremal and Buenaventura, Colombia, alt. 35-4000 ft., XII-11-1935 (A. E. Schwarz); Chanchamayo E. Peru (Rosenberg); Piches and Perene Vs Peru, 2,000-3,000 ft. (Lima); LaChorerra Puta, Mayo Distr. Peru, 17-20, Aug., 1920 (Cornell Univ. Exped. Lot 569) and Igrapinna, Bahia, Brazil, 23-29 June, 1919.

Plecia (*Plecia*) *costalis* Wiedemann

Plecia costalis Wiedemann, 1830, Ausereuropiasche Zweiflug. Ins. 2, 618. (nec *costalis* Walker.)

MALE.—Redescription of type. Black; rostrum short, much shorter than antennae; antennae nine segmented. Body entirely opaque. Thorax with very sparse, pale pile; upper portions of sternopleurae with long dark hairs. Male genitalia undissected, but the ninth tergum is deeply V-shaped cleft. The harpagones appear to be small and inconspicuous. Wings brown fumose, veins darker brown; costal margin, humeral crossvein, subcosta, base of wing and bases of R and R_{1+2} oblique. Fork of media situated before middle of distance from r-m crossvein to fork of radial sector. Halteres brown.

FEMALE.—Entirely opaque black. *Head:* Rostrum not greatly produced, slightly over one-half the length of the antennae; antennae eleven segmented, shorter in length than the palpi; compound eyes covered with short hair. *Thorax:* Dorsum with sparse, recumbent, brownish pile; sternopleurae each with a dense patch of black hairs above; stems of halteres yellow-brown, knobs brown. Legs and abdomen densely black pilose. *Wings:* Largely brown to blackish fumose with the costal margin and base of wing bright yellow (this is a striking characteristic of the species). Vein R_{3+4} oblique, with a very slight curve near its base; vein M_{3+4} situated at about the basal third of the distance from the r-m crossvein to the fork of the Rs.

Length male: 9.8-10.5 mm.; wing, 11-12 mm.

Female: body, 11-12 mm.; wing, 14.5-15.4 mm.

Described from Brazil. The writer has seen specimens from Petroplis, Rio de Janeiro. It has also been reported from Parana. Three specimens from the type series have been examined, one male and two females. Kindly loaned by Zoölogisches Museum der Universitat Berlin.

Plecia (Plecia) curvistylata Hardy

(Plate XXXI, figs. 137a-d)

Plecia (Plecia) curvistylata Hardy, 1942, Can. Ento. LXXIV, 107.

"This species is probably closer to the *collaris* group as the anterior portion of the mesonotum is discolored. This discolored area is, however, only slightly darkened and not distinctly blackened as in others of the complex. This species is also of much smaller size, the rostrum is not quite as long as the antennae and R_{3+4} is more decidedly curved before entering the costa (fig. 137a). The male genitalia will distinguish it.

"*Male genitalia:* Posterior lateral margins of the ninth sternum not developed, hind margin with a gentle concavity in the middle. Harpagones elongate and curved inward (fig. 137b), only their bases visible from ventral view (fig. 137c). Ninth tergum deeply concave on hind margin, wider than long (fig. 137d).

"Length: body, 3-3.5 mm.; wing, 3.6-4 mm."

Type locality: Cuernavaca, Morelos, Mexico.

Type to be returned to the British Museum.

Plecia (Rhinoplecia) dentata Hardy

(Plate XXXI, figs. 138a-d)

Plecia (Rhinoplecia) dentata Hardy, 1942, Can. Ento. LXXIV, 107.

"This species approaches *rufithorax* Walker and can be separated conveniently only by use of the male genitalia, these structures differ very distinctly. The wing venation also differs as follows: The fork of the radial sector (R_{3+4}) arises vertically toward the costa then makes a sharp turn into the wing margin (fig. 138a); fork of media situated slightly before middle of the distance between r-m crossvein and fork of Rs; Cu strongly curved downward, narrowing the cubital cell.

"*Genitalia:* Posterior margin of ninth sternum with a U-shaped concavity. Posterior lateral margins rather strongly developed. Harpagones large, blunt with a small beaklike apex as seen from ventral view (fig. 138c); from a lateral view a toothlike development is visible on the dorsal surface (fig. 138b). Apices of harpagones covered with dense short, brownish pile and long hairs. The exact shape of the clasping structures is difficult to discern and many interpretations may be had according to the angle from which they are viewed. If tilted downward the inner margin of the apex will appear much more blunt and rounding than shown in the figure.

Ninth tergum but little wider than long, with a small convexity on the posterior margin (fig. 138d).

"Length: body, 5-6 mm.; wings, 6.5 mm."

Type locality: Chontales, Nicaragua (Janson).

Type will be returned to British Museum.

Plecia discolor Van der Wulp

Plecia discolor Van der Wulp, 1881, Amer. Dip. I, Tijdschr. Ent. XXIV, 143.

The description of this species is too inadequate to place it properly, it belongs in either the *bicolor* or *collaris* group and may prove to be the same as *collaris* (Fabricius) but until the type can be located and studied its true position will remain questionable.

Type locality: Argentina.

Type probably at Amsterdam or Leiden.

Plecia (*Rhinoplecia*) *disparis* Hardy

(Plate XXXI, figs. 139a-b)

Plecia (*Rhinoplecia*) *disparis* Hardy, 1942, Can. Ento. LXXIV, 108.

"Related to *Plecia bicolor* Bell, but differing distinctly in the male genital structures; the wings also appear to be more lightly fumose.

"*Male genitalia:* Ninth sternum broad with a well developed median process on its posterior border (fig. 139a), apodeme of ninth sternum greatly developed and rounding at the apex, sometimes appearing to be a second lobe of the harpagones from a lateral view; harpagones broad, bluntly tipped. Aedeagus large and rounding with two heavily sclerotized supporting processes laterally. Ninth tergum moderately concave, the bottom of the concavity almost straight (fig. 139b).

"In other characters this species cannot be separated from *bicolor* Bell.

"Length: body, 5.3 mm.; wing, 6 mm."

Type locality: Upper Putamyo River, Colombia.

Type in the United States National Museum.

Plecia (*Rhinoplecia*) *ecuadorensis* Hardy

(Plate XXXII, figs. 140a-c)

Plecia (*Rhinoplecia*) *ecuadorensis* Hardy, 1942, Can. Ento. LXXIV, 108.

"This species is related to *rufithorax* Walker and can only be separated by the marked structural differences in the male genitalia. The specimens are of slightly larger size and vein R_{3+4} is curved rather sharply near the base (as is fig. 138a).

"*Male genitalia:* Approaches *xenia* Hardy in having the posterior lateral margins of ninth sternum strongly developed and the ninth tergum with a narrow slitlike invagination extending over one-third the length of the segment down the middle. Ninth sternum gradually convex on the hind margin with a strong acutely pointed development medianly (fig. 140). Harpagones large and somewhat irregular but without such processes as possessed by *xenia*, developed into a rather acute point apically above, as seen from a ventral view and with a sharp toothlike point above from a lateral view (fig. 140b). Ninth tergum longest on the lateral margins, gently concave on the posterior margin; segment wider than long (fig. 140c). The genitalia differs from *xenia* in the development of the tergum, sternum and harpagones.

"The female genitalia have not been dissected.

"Male length: body, 6-6.5 mm.; wing, 7-8 mm.

"Female length: body, 7-7.5 mm.; wing, 8-8.5 mm."

Type locality: Ecuador, S. America.

Type to be returned to the British Museum. At present in the Snow Entomological Collection.

The species has also been recorded from Pasto, Colombia.

Plecia ecuadorensis micans Hardy

(Plate XXXII, figs. 141a-b)

Plecia ecuadorensis var. micans Hardy, 1942, Can. Ento. LXXIV, 108-109.

"This variety differs from the type species in having the mesonotum and lower portions of the sternopleurae shining reddish instead of opaque yellow-orange; the variety is also smaller in size. The females are sometimes marked with black on the dorsum, one specimen has the entire thorax deeply black tinged.

"*Female genitalia:* Ninth tergum with a broad, flat bottomed cleft on hind margin; posterior lateral margins rounded. Cerci rounded apically, longer than wide (fig. 141b). Eighth sternum distinctly divided into two plates by a deep cleft extending down the middle longitudinally, posterior margins of each plate produced into a large rounding median lobe and a moundlike swelling toward the sides; segment about twice as wide as long (fig. 141a).

"Male length: body 3.5-4 mm.; wing, 5-5.5 mm.

"Female length: body, 5 mm.; wing, 6.5 mm.

"These would certainly appear to belong to a different species but the male genitalia are identical. This is the only example the writer has encountered in the *rufithorax* group in which the thorax is not opaque."

Type locality: Guayaquil, Ecua.

Type in the United States National Museum Collection.

This variety has also been recorded from Hulgra, Ecuador.

Plecia (Rhinoplecia) edwardsi Hardy

(Plate XXXII, figs. 142a-b)

Plecia edwardsi Hardy, 1940, Journ. Kan. Ent. Soc. 13, 17.

Following is the original description:

"This is a sexually dimorphic species related to *Plecia seminitens* Edwards, the males differing in having the mesonotum almost entirely shining, not divided into stripes by gray vittae, only a small slightly grayed spot behind the humeral ridges and a narrow line of gray along lateral margins of mesonotum. The median groove of the notum is as deep as the lateral ones; the posterior tarsal segments are noticeably swollen and rounding. The genitalia are also very different, *edwardsi* does not have the posterior margin of the ninth tergum nearly straight and the harpagones bilobed as does *seminitens* Edwards. The females differ in having the thorax entirely rufous. Vein R_{2+3} (R_{3+4}) is markedly curved in the males and more oblique in the females.

"*Male genitalia:* Ninth sternum slightly convex on median posterior margin with a moundlike membranous gibbosity in the middle, posterior lateral margins not greatly developed, irregular, with two to three small rounded developments. Harpagones simple and vertical in position, not lateral as in *seminitens*, terminating in a small point apically and a blunt rounded projection on inner side (fig. 142a). Ninth tergum deeply U-shaped concave (fig. 142b).

"Male length: body, 2.5-3 mm.; wing, 3-3.2 mm.

"Female length: body, 2.7-3 mm.; wing, 3.5-3.7 mm.

"Type locality: Jussara, Angro Dos Reis, Brazil."

Type in the Snow Entomological Collection.

Plecia fulvimacula Walker

Plecia fulvimacula Walker, 1848, List of Dipt. Brit. Mus. I, 116.

Plecia flavimaculata Hunter, 1900, Trans. Amer. Ent. Soc. XXVI, 297. (This is an erroneous spelling for *fulvimacula*).

From the description this appears to belong to the *collaris* group. The writer is unable to place it, so is quoting the original description.

"Nigra, thoracis lateribus fulvo maculatis, metathorace rufofusco, abdomine picco, antennis nigris, femoribus basi piceis, alis nigrofuscis.

"Body black, shining; feelers black; chest with a large tawny spot

on each side above the base of the wing; hind chest reddish brown; abdomen dull piceous: legs black, shining; thighs piceous towards the base: wings dark brown, specially towards the fore border, where there is a small narrow black band; veins and poisers piceous. Length of the body 4 lines; of the wings 8 lines."

Type locality: Venezuela.

Type in British Museum.

Type in the United States National Museum.

Doctor John Smart has recently informed the writer that the *fulvimacula* type appears in the British Museum collection under the genus *Dilophus*; if this is correctly placed it seems strange that Walker should have described it as a *Plecia*.

Plecia (*Rhinoplecia*) *gibbosa* Hardy

(Plate XXXII, figs. 143a-e)

Plecia (*Rhinoplecia*) *gibbosa* Hardy, 1942, Can. Ento. LXXIV, 109.

"This species is closely related to *rostellata* Loew because of the structural similarities. The rostrum is not so long as in that species, being about as long as the head, slightly shorter than the antennae and the genitalia of both sexes differ considerably. The harpagones are more sharply pointed, the median lobe of the sternum is membranous and rather square-topped; the hind margin is produced into a pair of rounded lobes at the base of the claspers and the posterior lateral lobes are more strongly developed, extending over one half the length of the claspers. From end view the hind margin of the tergum is seen to fold back, producing a broad shelflike portion extending around the upper part of the genital chamber; the median portion is developed into a strong point (fig. 143c). The mesonotum of the male has sparse, short black hairs on the sides; propleurae and anterior part of mesopleurae and sternopleurae with somewhat obscure brown markings. Abdomen more sparsely haired, with fine, light brown pile; also of smaller size. In addition to the above the posterior lateral margins of ninth sternum are developed, hind margins with a median gibbosity of a somewhat membranous nature. Harpagones simple, with beaklike apices (fig. 143e). Ninth tergum concave on the posterior margin, with a small convexity in the bottom of the cleft (fig. 143d).

"*Female genitalia:* Eighth sternum completely divided into two plates by the median cleft. Median lobes of hind margin rounded; lateral lobes square topped, extending less than one-half the height of the median pair; segment much wider than long (fig. 143b). The

lateral lobes of *rostellata* are acutely pointed and the entire segm nt is differently shaped. Ninth tergum about four times as wide as longest point, with a very broad, deep cleft on hind margin and a distinct convexity in the bottom of the cleft (fig. 143a). This sclerite differs strikingly from *rostellata* in that the anterior lateral margins are not at all produced and the bottom of the cleft not square.

"Male length: body, 5.5-6 mm.; wings, 6.5 mm.

"Female length: body, 7 mm.; wings, 8 mm."

Type locality: S. Bernardino, Paraguay.

Type in the United States National Museum.

The species has also been recorded from San Jose, N. Arg.

Plecia (Rhinoplecia) grisea Edwards

(Plate XXXII, figs. 144a-b)

Plecia (*Rhinoplecia*) *grisea* Edwards, 1938, Ann. Mag. Nat. Hist. Ser. 11, No. 10, 322-323.

The following are diagnostic points taken from the original description with a few additions by the writer: Black, without markings; only the stems of halteres pale; antennae eight segmented; rostrum about as long as antennae; thorax almost uniformly dusted, even on scutal stripes, appearing gray when viewed from the front; sternopleurae with a few short pale hairs; wings smoky. Female coloring as in male, head gray dusted, vein R_{3+4} (R_4 of Edwards) more oblique than in male. Antennae eleven segmented. The male specimen examined has a faint reddish tinge on margins of mesonotum, scutellum, postnotum, metapleurae and hypopleurae. The abdomen is also yellow haired.

Male genitalia: Ninth sternum with a blunt, median development on hind margin, posterior lateral margins produced. Harpagones rather large and terminating in a blunt point (fig. 144a). Ninth tergum gently concave, with a small bumplike swelling in the middle (fig. 144b). Doctor Edwards has stated that the tergum has a broad V-shaped excavation and a small bilobed process at bottom of V. The tergum of the specimen examined hardly fits this. The writer is unable to find any bilobed condition in the median process, from a dorsal view. By tipping the segment forward this bump appears to be slightly notched in the middle and the process spoken of may fold backwards so it would not be visible in some specimens.

Wing length: male, 7 mm.; female, 9 mm.

Doctor Edwards has suggested that this might be a variety of *maura* Walker, but this writer would consider them very distinct

species, the ninth tergum and the sternum as well as the characters given by Edwards separate them.

Type locality: Nova Teutonia, Brazil.

Type in British Museum.

Specimen examined from the type locality, presented by Doctor Edwards.

Plecia (*Plecia*) *imperialis* Schiner

(Plate XXXII, figs. 145a-b)

Plecia imperialis Schiner, 1867, Diptera, Beise der Osterreichischen Fregatte um die Erde. 22.

This species is readily recognized by the blackish costal margin of the wings and the distinctive genital characters.

MALE. — Large, opaque black, chiefly bare species. Compound eyes not divided by a transverse depression; face densely black haired. Rostrum not greatly produced, little over half the length of antennae. *Thorax:* Very faintly grayed, sternopleurae bare or with but a few short hairs. Mesonotum with but a few scattered hairs and with two rather faint longitudinal furrows which converge slightly before the scutellum. *Wings:* Largely yellowish, the costal margin broadly blackish from base to apex; stigma concolorous with the membrane of the costal margin. Vein R_{3+4} short, almost vertical, very slightly curved. *Genitalia:* Ninth sternum about as long as wide, posterior lateral margins produced into a pair of elongated hairy lobes; posterior median margin square topped with a concavity at the base of each clasper. Harpagones rather small, shining black and slender, folded inward toward genital chamber in normal position (fig. 145a). The ninth tergum is almost completely divided into two lobes by deep clefts on its posterior and anterior margins, only a very narrow bridge of sclerite joins the two lateral lobes; the posterior margin of tergum is armed with strong bristles (fig. 145b).

Length: body and wings, 9.3-10 mm.

Schiner states that the female is comparable to the male but is of larger size and other than sexual characters the yellow coloring of the wings is more extensive.

Type locality: Colombia.

Type in Vienna Natural History Museum.

The writer has a male specimen from Fusagasuga, Colombia (Apolinar Maria).

Plecia (Rhinoplecia) impilosa Hardy

(Plate XXXIII, figs. 146a-b)

Plecia impilosa Hardy, 1940, Journ. Kan. Ent. Soc. 13, 17-18.

Following is the original description:

"This species is related somewhat to *grisea* Edwards and *maura* Walker, it differs in coloration and is not so consistantly grayed as *grisea;* the wings are more yellowish and the genital characters are distinctive.

"MALE.—Chiefly black species. *Head:* Rostrum developed, longer than the antennae, antennae eight segmented; compound eyes not noticeably divided into two portions. *Thorax:* Chiefly bare, with only microscopic hairs on upper portions of sternopleurae and on dorsum. Humeral ridges brick-red; margins of mesonotum, scutellum, metanotum, pteropleurae, metapleurae and hypopleurae with an ochraceous to reddish tingue, this sometimes extends along the mesonotal furrows. Mesonotum chiefly gray dusted, this pruinosity is more distinct on the front sides and in the middle of the furrows; mesopleurae and sternopleurae grayed, the latter subshining on lower portions. Notum with two rather deep furrows and with a faint median one between, these terminate in a pitlike area just before the scutellum. Legs and abdomen black with dense black pile. *Wings:* Yellow fumose, costal cell and stigma brown, veins dark brown to black; vein R_{2+3} (R_{3+4}) gently curved into the costa.

"*Genitalia:* Ninth sternum broad, posterior lateral margins strongly produced, posterior median margin with a U-shaped concavity and a moundlike elevation in the middle. Harpagones rather sharply pointed, as seen from a ventral view (fig. 146a). Ninth tergum deeply concave, the cleft extending over one-half the length of the segment; with a broad, somewhat square protuberance in the center (fig. 146b).

"Length: body, 6-7 mm.; wing, 7-8 mm.

"FEMALE.—The reddish tinge is more pronounced and more extensive, marking off four opaque black stripes down the dorsum; pleurae entirely tinged; pile even more microscopic; antennae eleven segmented and the wings are more yellow fumose.

"Length: body, 8-9 mm.; wing, 9.5-10 mm."

Type locality: West border, Matto Grosso, Brazil.

Type in United States National Museum Collection.

Plecia (Plecia) incurvata Hardy

(Plate XXXIII, figs. 147a-c)

Plecia (Plecia) incurvata Hardy, 1942, Can. Ento. LXXIV, 110.

"This species belongs in the *confusa* complex but differs strikingly from all other species known to the writer. The male genitalia resembles *parvistylata* Hardy in having the posterior lateral margins of the sternum produced but the harpagones are more elongate and the ninth tergum more deeply concave (fig. 147c) but not developed clasperlike as in *confusa* Loew. The compound eyes are distinctly divided into upper and lower portions by a partitioning line or groove running across the middle. This is the first time the writer has observed this character in the *confusa* complex. The wing venation is also distinct in this species.

"MALE.—*Head:* Antennae entirely black, consisting of ten segments, including a nipplelike tip. Rostrum slightly over one-half the length of the antennae. Mesonotal furrows not so deep as in *parvistylata*. *Wings:* Vein R_{1-2} merging with R_{3+4} at its tip, far removed from the end of the subcostal vein; R_{3-4} arising vertically to the costa. Fork of media situated at about basal one-fourth of the distance between r-m crossvein and the fork of the radial sector. Vein R_5 strongly curved inwardly toward anterior margin behind the fork of the Rs (fig. 147b). Wings dark brown fumose on costal margin, stigma barely discernible from the membrane. *Genitalia:* Ninth sternum moderately concave medianly on hind margin, posterior lateral margins developed into clublike lobes (fig. 147a). Harpagones rather small, elongate and projecting inward, usually only bases visible from ventral view (those figured in fig. 147a are slightly out of position to show their shape). Ninth tergum deeply cleft, about three-fourths its length (fig. 147c); tergum extending much beyond hind margin of the ninth sternum.

"Length: body, 5.5 mm.; wing, 6.5-7 mm.

"Female unknown."

Type locality: Guadeloupe Island, West Indies.

Type in the United States National Museum.

Plecia (Rhinoplecia) lateralis Hardy

(Plate XXXIII, figs. 148a-c)

Plecia lateralis Hardy, 1940, Journ. Kan. Ent. Soc. 13; 18-19.

Following is the original description:

"This species is near *grisea* Edwards separating most conveniently by use of the male genitalia; the antennae of the male are nine

segmented instead of eight, the furrows of the notum more distinct, humeri and scutellum not reddish tinged, vein R_{2+3} (R_{3+4}) more vertical, the occiput is densely black haired, the sternopleurae with conspicuous dark hairs above and the abdomen dark haired.

"MALE.—In addition to the above, the rostrum is very thick and pronounced, slightly shorter than the antennae. *Thorax:* Notum rather evenly gray pruinose, slightly more grayed in the furrows and on the margins. Pleurae opaque brown to black; legs and abdomen brown; halteres brownish yellow. *Wings:* Brown fumose, stigma concolorous with the membrane. Vein R_1 (R_{1+2}) ending beyond the middle of the distance from subcosta to vein R_{2+3}; R_{2+3} almost vertical with but a very slight curve near base; fork of media situated just before middle of distance from r-m crossvein to the fork of Rs.

"*Genitalia:* The ninth sternum is broader than long, with a troughlike concavity in the middle on the hind margin, posterior lateral margins not produced. The harpagones are rather long, appearing simple from ventral view, and more lateral in their position (fig. 148a); in this respect they are more like *Penthetria* than any other *Plecia* which have been observed. From a lateral view an inward developed process can be seen near their bases (fig. 148b). Ninth tergum with a slight convexity in the middle on hind margin (fig. 148c). Entire genitalia densely haired.

"Length: body, 5.5 mm.; wing, 5.5 mm.

"Female unknown."

Type locality: San Miguel, Hidalgo, Mexico.

Type in Cambridge Museum of Comparative Zoölogy.

Plecia (*Rhinoplecia*) *lindneri* Edwards

(Plate XXXIII, figs. 149a-c)

Plecia lindneri Edwards, 1931, Konowia, Bd. X. Heft 1, 75-76.

This species belongs in the *collaris* group by having the anterior portion of the mesonotum blackish, the dorsum of the thorax being otherwise rufous. It is very characteristic in that the thorax is entirely opaque instead of shining and the genital structures are distinctive.

The following is the original description:

"Head blackish, but considerably dusted with gray. Eyes almost or quite bare in both sexes. Ocellar tubercle large. Few or no hairs on face near antennae or on clypeus. Antennae with scape and basal half of first flagellar segment ocherous-brown, rest darker brown; flagellum 5-segmented in male, 8-segmented in female. Mouth-parts

(with clypeus) bent backwards at rest, almost as long as head. Thorax dull, with gray dusting over the whole surface; colour of integument (beneath the gray pollen) mainly red above, but with a large blackish area on front of mesonotum, pronotal angles remaining reddish. Scutellum in male with a black median line. Pleurae mainly blackish and almost bare; a few very short reddish-brown hair. Hypopygium of male normal in size, ninth tergite with a shallow median emargination forming two rounded lobes. Legs dark brownish, femora lighter except towards tips; pubescence short. All femora rather short, but slender except towards tips; all tibiae slender. Wings smoky, somewhat darker in costal cell, stigma indistinct. Venation normal. Halteres with reddish stem and black knob."

Length of body, 6-7 mm.; wing, 7.5-9 mm.

The following description of the male genitalia is added: The ninth sternum is much longer than wide with the posterior median margin greatly developed beyond bases of harpagones; the posterior lateral margins are not greatly produced. The harpagones are strong, elongated and bluntly tipped from ventral view, plainly visible and extending slightly beyond the apex of the ninth segment (fig. 149a); from lateral view the harpagones are seen to possess two acute teeth on inner edges (fig. 149b). The internal apodemes are well developed and simulate secondary lobes of the harpagones. From lateral view, looking into the genital chamber, their apices are heavily sclerotized and may actually serve as clasping structures. The ninth tergum has a moderately V-shaped concavity on hind margin (fig. 149c).

Type locality: El Cairo, Northwest, Santa Cruz de la Sierra, Bolivia.

The writer has identified the species from West border Matto Grosso, Brazil, May 31 (R. C. Shannon) and Asupisu to Miriantiriani, Cam. del Pichia, Peru, July 9, 1920 (Cornell Exped. Lot 607, Sub. 132).

Plecia (*Rhinoplecia*) *lopesi* Hardy

(Plate XXXIII, figs. 150a-c)

Plecia lopesi Hardy, 1940, Journ. Kan. Ent. Soc. 13, 19-20.

This species is related to *bicolor*, but is readily distinguished by the genital characters. The specimens are of larger size than *bicolor* and the wings are darker fumose; the dorsum of the thorax is not so shining and that of the male is tinged with brownish. Following is the original description of the male genitalia:

"*Male genitalia:* Ninth sternum with a sharp triangular shaped projection in the middle on its posterior edge, posterior lateral margins not greatly developed, claspers broad and rather sharply pointed from ventral view (fig. 150b). Ninth tergum gently and broadly concave on posterior margin (fig. 150c)."

Length: body, 6.5-7 mm.; wing, 7.5-8 mm.

Female.—Specimens slightly larger in size, dorsum of thorax more brightly colored; the pleurae slightly tinged with reddish and the antennal segments more compacted. Otherwise like the male.

Length: body, 7 mm.; wing, 9-9.5 mm.

Type locality: Eug. Lefevre, San Paulo, Trav., Brazil.

Type in Snow Entomological Collection.

Plecia (*Rhinoplecia*) *maculata* Hardy

(Plate XXXIII, figs. 151a-b)

Plecia (Rhinoplecia) maculata Hardy, 1942, Can. Ento. LXXIV, 110-111.

"This species approaches *rostellata* Loew in the development of the rostrum and its larger size but is very different from this species. The blackened pleurae and dark brown costal section of the wing together with its distinctive genitalia will separate it.

"MALE.—*Head:* Antennae black with a barely perceptible brownish tinge, eight-segmented, the last five segments of the flagellum almost round. Rostrum much longer than the antennae, mouth parts entirely black. *Thorax:* Opaque, mesonotum rufous with a median brown to black stripe extending backward from the anterior part of the dorsum, this is divided down the middle by a fine rufous line. Mesonotum also with a brownish discolored area on each side behind the middle. Scutellum with a black spot in the center. Pleurae chiefly brown to black with rufous markings on the hind portions of the sterno and mesopleurae and the middle of the pteropleurae. Knobs of halteres black, stems pale. Thorax entirely bare, with but microscopic pubescence. *Wings:* Brown fumose at base and on anterior margins, anterior veins dark brown. Posterior portion of wing almost hyaline, just slightly fumose. Vein R_{3+4} arising almost vertically into the costa (fig. 151c). Fork of media at about the basal one third to one fourth the distance between the r-m crossvein and the fork of the Rs. Cu_1 sharply curved downward at its tip. Abdomen shining black with dense black pile. *Genitalia:* Ninth sternum large and very irregularly developed on posterior edge, posterior lateral margins produced into rather strong lobes. Harpagones of medium size with only bases visible from a ventral

view (fig. 151a), developed into a beaklike point on the inner side, as seen from a lateral view (fig. 151b). Ninth tergum deeply and narrowly concave, the cleft extending to about the basal one third of the segment (fig. 151d).

"Length: body, 8.5-9 mm; wing, 9 mm.

"Female unknown."

Type locality: W. Indies, E. Coast, Trinidad, Mayaro.

Type will be returned to the British Museum.

The species has also been recorded from Port of Spain, Trinidad.

Plecia marginata Edwards

Plecia marginata Edwards, 1920, Mission Arc. Meridien Amer. Sud. 10, 148.

The original description is in French, the following is a translation:

"Body 6 mm.-8 mm.; wing 11 mm.-13 mm. Head with its appendages dull black, scape of the antennae more pale. Thorax: mesonotum dull black with a narrow but continuous orange border; scutellum and postnotum orange; pleurae dark brown, more or less intermixed with brownish orange. Abdomen reddish brown above and below, clothed with short pale pubescence. Feet ochraceous brown; extremities of the femora, tibiae and tarsi dark brown, with blackish pile. Wings slightly brownish tinged, veins brown, stigma round, of a brownish gray color. Venation as in *P. nitidipes* Edwards. Stems of halteres ochraceous, knobs dark."

Described from Equador.

Type in British Museum.

The writer has not seen this species but it should be easily recognized by the orange border on the mesonotum and the reddish pleurae and abdomen.

Plecia (*Rhinoplecia*) *maura* Walker

(Plate XXXIII, figs. 152a-d)

Plecia maura Walker, 1837, Trans. Linn. Soc. London, XVII, 336.
Plecia velutina Macquart, 1844, Dipt. Exot. Suppl. 1, 149.

This is a very large entirely black species, the mouthparts are produced about as long as the antennae; antennae of male eight segmented, female eleven segmented. *Thorax:* Opaque, almost devoid of pile, with only a few microscopic yellow hairs, upper portion of sternopleurae likewise. Legs and abdomen subshining with dense black pile. *Wings:* Brown to black fumose, darker along costal margin, stigma only faintly discernible. Vein R_{3+4} short and almost vertical in male, longer, more oblique in female. *Male*

genitalia: The ninth sternum and harpagones are very much like those of *grisea* Edwards but the posterior lateral margins of the sternum are not so developed and the median protuberance is more acutely pointed, with a membranous swelling behind; hind median margin also more concave (fig. 152a). The ninth tergum is more deeply concave and no median development is present (fig. 152b).

Female genitalia: Ninth tergum broadly H-shaped, a narrow sclerotized bridge connecting the two lateral lobes of the segment. Cerci large, conspicuous and rounding (fig. 152d). Eighth sternum very characteristic in shape, posterior median margin produced into two pairs of strong lobes, the inner pair rounding and densely haired, the two outer lobes are sharply pointed from ventral view (fig. 152c), shining black and bare. From lateral view the outer lobes are greatly flattened and extended into the genital chamber to give support to the oviposition apparatus.

Male length: body, 8-9.5 mm.; wing, 9-11 mm.

Female length: body, 8.5-10 mm.; wing, 10.5-13 mm.

Type locality: Brazil.

Type in British Museum.

Specimens have been examined with Brasilien Nova Teutonia 27° 11′ S. lat., 52° 23′ W. long. (Fritz Plaumann); Parque do Estado S. Paulo, Oct. 25, 1934 (L. Trav.); Angra dos Reis Est. do Rio (D. Mendes); Angra-Jussaral, Dec. 1926 Travassos and Oticica (J. Lins); Petropolis, Rio de Janeiro, Brazil, Oct. 24-27, 1919 (Cornell Univ. Exped.).

Plecia (*Rhinoplecia*) *nearctica* Hardy

(Plates XXXIII-XXXIV, figs. 153a-e)

Plecia nearctica Hardy, 1940, Journ. Kan. Ent. Soc. 13, 20-21.

This species is related to *bicolor* Bellardi but the male genital structures are very distinctive, the bilobed harpagones and strong development of the posterior median margin of the ninth sternum separate it from other known species. Following is the original description of the male genitalia:

"*Male genitalia:* Ninth sternum somewhat narrowed distally with a small concavity on the posterior margin of the middle (fig. 153b). Claspers bilobed, both arms terminating in a beaklike point; the outer lobe is much stouter and vertical in position, visible from dorsal view; the inner lobe is smaller, more narrow and horizontal in position, directing inwardly and visible only from a lateral view

(fig. 153c); the claspers are densely haired. The ninth tergum is gently concave on the posterior margin (fig. 153a)."

Length: body, 4-5 mm.; wing, 4.5-5.3 mm.

Female genitalia: The eighth sternum terminates in a pair of rounding lobes, median cleft deep, extending almost to base of sternum; a sharp tooth is present on inside margin of each of the median lobes. A pair of sclerotized processes surround the vaginal opening, arising from the median portion of the genital chamber (fig. 153d). The ninth tergum is broad, its posterior margin with a deep U-shaped cleft (fig. 153e).

Length: body, 5-6.3 mm.; wing, 5.5-7.3 mm.

Type locality: Galveston, Texas.

Type in Snow Entomological Collection.

This species is widely distributed in the South, having been recorded from the following states and Central American countries: Costa Rica, Guatemala, Honduras, Louisiana, Mexico, Mississippi and Texas; apparently more common in Texas, Louisiana and Mississippi.

Plecia (Plecia) nigra (Philippi)

(Plate XXXIV, figs. 154a-c)

Penthera nigra Phil., 1866, Aufzahlung der Chilenischen Dipteren, Verh. Zoöl. Bot. Ges. Wien. v. XV, 639-640.

MALE.—Opaque black with a very characteristic vestiture of long black hair over the entire body, including the eyes. *Head:* Rostrum rather short, not one-half the length of the antennae. Antennae ten segmented, including the nipplelike tip. Compound eyes divided slightly below the median horizontal line, separating them into an upper and lower portion. Lower portion of eyes, occiput, face and ocellar tubercle densely haired. *Thorax:* Thickly haired on the dorsum, hypopleurae, middle of pteropleurae and upper portions of sternopleurae. Scutellum almost bare, only sparsely haired; halteres testaceous with blackish tinge. *Wings:* Yellow-brown fumose, veins dark brown, stigma but slightly darker than the membrane. Vein R_{3+4} oblique, scarcely curved (fig. 154a); fork of media situated before the middle of the distance from the r-m crossvein to the fork of the radial sector. *Genitalia:* Ninth sternum very irregular on hind margin, with three pairs of rounded lobes besides a median moundlike development; posterior lateral margins strongly produced, the median pair of lobes finely toothed on the inner margins (fig. 154c). Harpagones long and slender, folded downward into the

genital chamber in normal position. Ninth tergum gently concave, with a very prominent median process (fig. 154b).

Length: body, 4.7-5 mm.; wing, 6-6.2 mm.

Female unknown.

Type locality: Chile.

Type probably in the Santiago National Museum.

This is the only species of *Plecia* which has been recorded from Chile. The writer has examined a specimen from Corral, Valdivia, presented by the late Doctor Edwards of the British Museum.

Plecia (*Rhinoplecia*) *nitidicollis* Edwards

(Plate XXXIV, figs. 155a-c)

Plecia nitidicollis Edwards, 1931, Ann. Mag. Nat. Hist. Ser. 10, v. VII, 260-261.

Black species; rostrum greatly produced, longer than the antennae and equal to or longer than the head. *Thorax:* Mesonotum with three brightly shining stripes separated by opaque lines running down the notal furrows, median stripe undivided, median furrows very faint; chiefly bare with only sparse black hairs on the upper portion of the sternopleurae, lower portion of sternopleurae subshining. *Wings:* Brownish to smoky fumose, stigma faintly discernible; vein R_{3+4} gently curved into the costa; fork of media situated at about the basal one-third of the distance from the r-m crossvein to the fork of Rs. Hind tibiae clavate, posterior tarsal subsegments slightly swollen. *Male genitalia:* Ninth sternum broad, very faintly concave on hind margin. Harpagones broad, ending in two rather blunt points as seen from a ventral view (fig. 155b), produced inwardly into a large rounded lobe from a lateral view (fig. 155c). Ninth tergum with a slight concavity on hind margin and with a pair of inward projections in the middle (fig. 155a), these are triangular shaped as seen from an end view.

Length: body, 5-5.4 mm.; wings, 6-6.7 mm.

FEMALE.—The median stripe is sometimes divided by a faint grayish line down the middle furrow. Hind tibiae straight, all tarsi slender. The dorsum of the thorax is sometimes rather dull, only subshining. *Genitalia:* Ninth tergum about twice as wide as long, cleft one-third to one-fourth its length on both anterior and posterior margins; cleft of anterior margin broadly U-shaped, that of hind margin with a broad flat bottom and almost straight sides. From ventral view the eighth sternum is about twice as wide as long, the posterior median lobes not strongly developed; the sternum is divided into two plates by a median longitudinal cleft. A pair of

large black sclerotized plates occupy the ventral portion of the genital chamber just above the lobes of the eighth sternum; these plates are attached to the bases of the ninth tergum and probably serve as egg guides.

Species described from Castro, Parana, Brazil.

Type in the British Museum.

The writer has examined two paratopotypes; also specimens from the following localities: Eng. Lefevre (Est. de S. Paulo) I-XI-1937 (N. Santos-Lopes et Oiticica) and San Paulo-Cantareira (Serra), 7-9-1934 (S. Trav).

Plecia (*Plecia*) *nitidipes* Edwards

(Plate XXXIV, figs. 156a-d)

Plecia nitidipes Edwards, 1920, Mission Arc. Meridien Amer. Sud. 10, 147-148.

This species was described from females and the male has heretofore been unknown. All of the specimens of this complex that the writer has examined from Ecuador have belonged to one species and specimens of this series have been compared with the type by Doctor Edwards and declared to certainly belong to *nitidipes*.

MALE.—*Head:* Rostrum not developed, antennae ten segmented. *Thorax:* Entirely opaque, with short recumbent yellow pile on dorsum, erect brown to black hairs on upper portion of the sternopleurae, sides of mesonotum and area behind humeral ridges coarsely rugulose, mesonotum noticeably but not deeply furrowed. Legs and abdomen brown to black the latter with thin pale pile. *Wings:* subhyaline, but faintly smoky; fork of third vein (R_{2+3}) oblique, with a gentle curve into the costa; fork of media situated near the middle of the distance between the r-m crossvein and the fork of the Rs. *Genitalia:* Posterior margin of ninth sternum with two pairs of processes, two strongly developed lateral lobes and two median lobes; the area between the median lobes is concave with a small bump in the center. These processes are covered with strong hairs and bristles. Harpagones long and slender with a beaklike point on the inner apices (fig. 156a). The harpagones are folded down into the genital chamber in their normal position and usually cannot be seen from ventral view. The ninth tergum is deeply excavated on the posterior margin and possesses a characteristic pointed protuberence in the middle (fig. 156b). The genitalia of this species show that it is close to *plagiata* Wd. The only notable difference being the central toothlike projection of the tergum.

Length: body, 6-6.5 mm.; wings, 7.5-9 mm.

FEMALE.—Larger specimens, body 8.6 mm.; wings, 12 mm., antennae eleven segmented. *Genitalia:* Eighth sternum completely divided into two plates by a longitudinal median cleft, posterior margins produced into a pair of densely haired, rounded lobes (fig. 156c). Ninth tergum very broad and narrow, four times as wide as its greatest length; densely haired with a characteristic spinelike process in middle on hind margin (fig. 156d).

Described from Ecuador.

Type in British Museum.

Specimens have been examined from Quito, Ecuador, 2850 ft., (F. Campos); Canar, Ecuador, 2600, April (Lichtwardt); Cuicocha, 3300 m., Imbabura, Ecuador, May 27-31, 1939 (F. M. Brown); Cumbre Tililac, Chimborazo, 4200 m., Ecuad., June 21, 1939 (F. M. Brown); Urbina Cerra, Chimborazo, Ecuad. 3650 m., April 18, 1939 (F. M. Brown).

Plecia (*Rhinoplecia*) *panamaensis* Hardy

(Plate XXXIV, figs. 157a-d)

Plecia (Rhinoplecia) panamaensis Hardy, 1942, Can. Ento. LXXIV, 111-112.

"This species can be separated from *rufithorax* Walker only by the genital characters but these structures are so distinct that there can be no doubt of its identity, even in undissected specimens. The long processes on the hind margin of the ninth sternum will separate it readily from any species known to the writer.

"*Male genitalia:* Posterior margin of ninth sternum produced into two long outward projecting prongs with a deep V-shaped cleft between; on the outer margins of these median developments, just below their middles, a slender sclerotized rod extends underneath the apical margin of the segment to attach to the body wall at the bases of claspers (fig. 157c). These rods probably serve for muscle attachments. Harpagones rather strong, somewhat broadened apically, pointed inwardly on their apices from a ventral view. Posterior lateral margins of tergum slightly developed; segment broader than long, with a small V-shaped excavation in the middle on the hind margin, as seen from a dorsal view (fig. 157b). The tergum folds back on the posterior edge producing a broad flat area before the anal region. If the genitalia are tilted forward the ridges at the back will give a different perspective than the one figured.

'Length male: body, 5.2-5.8 mm.; wing, 6 mm.

"*Female genitalia:* Eighth sternum almost twice as wide as long, the posterior median pair of lobes rather acute and slightly concave

on inner margins; hind margin of each plate with a distinct concavity in middle and a broad rounding outer lobe (fig. 157a). Ninth tergum only twice as wide as its greatest length, deeply cleft on hind margin, with only a narrow strip of sclerite joining the two lateral plates (fig. 157d).

"Length female: body, 6.7 mm.; wing, 7.4 mm."

Type locality: Cano Saddle, Gatun L. Panama.

Type in the United States National Museum.

The species has also been recorded from the following localities in Panama: Boqueron River, Cabima, Tubernilla, Canal Zone and Barro Colorado.

Plecia (*Plecia*) *parvistylata* Hardy

(Plate XXXIV, figs. 158a-b)

Plecia (Plecia) parvistylata Hardy, 1942, Can. Ento. LXXIV, 112.

"Related to *confusa* Loew but more closely approaching *incurvata* Hardy structurally. It separates from either of these by the shape of the ninth tergum and the harpagones.

"MALE.—Beak shorter than antennae and scarcely visible. Antennae nine segmented, brownish yellow. Thorax deep orange; the outside median furrows of the mesonotum are more deeply grooved and the legs more densely haired than any which have been observed in the *confusa* complex. The legs are shining black and very densely covered with long black hair. *Genitalia:* Ninth sternum gently concave on the posterior margin, posterior lateral margins rather strongly developed into knoblike lobes; harpagones very small and folded inwardly, pointed on the outer apical edge (fig. 158a). Ninth tergum only moderately concave with a strong median projection on hind margin (fig. 158b).

"Length: body, 4.5-5 mm.; wing, 6 mm.

"Female unknown."

Type locality: Antigua, Guatemala.

Type in the United States National Museum.

Plecia (*Rhinoplecia*) *perplexa* Hardy

(Plate XXXIV, figs. 159a-d)

Plecia (Rhinoplecia) perplexa Hardy, 1942, Can. Ento. LXXIV, 112.

"Related to *bicolor* Bell. and *collaris* (Fabr.) but easily separated by the unusual development of the male genitalia. The male has a small black area on the anterior portion of the dorsum placing it in the *collaris* group but in the female this is but faintly darkened.

"*Male genitalia:* Ninth sternum wider than long, longest on a

median line, with two moderate developments on hind margin near median portion. Between these median lobes is a slightly convex area. The posterior lateral margins of sternum are scarcely produced. Harpagones broad at their bases, each terminating in a narrow fingerlike development apically, minutely shagreened on inner surfaces. A clasperlike process projects outward from each side of the aedeagus, developed almost as long as the harpagones and plainly visible from ventral view (fig. 159c). These are apparently accessory lobes of the aedeagus and appear to be attached to this organ by membrane along their inner sides, however, they terminate basally in two appendages which might serve for muscular attachments (fig. 159d), suggesting that they are possibly functional as clasping structures. Ninth tergum with a V-shaped excavation on posterior margin, from a dorsal view (fig. 159a); the hind margin is folded inward and developed into two rounded lobes as seen from an end view (fig. 159b).

"Male length: body, 4.3 mm.; wing, 4.8 mm.

"Female length: body, 4.3 mm.; wing, 5.5 mm."

Type locality: Cuba, 226 (Loew).

57

Type in Cambridge Museum of Comparative Zoölogy.

The species has also been recorded from Buenos Aires, Trinidad Mts., Cuba.

Plecia (*Rhinoplecia*) *persimilis* Hardy

(Plate XXXV, figs. 160a-e)

Plecia persimilis Hardy 1940, Journ. Kan. Ent. Soc. 13; 21-22.

This species is related to *seminitens* Edwards but has the wings yellow to yellow-brown fumose instead of dark smoky fumose and the legs are more consistantly rufous tinged. The posterior median margin of the ninth sternum is not produced as in *seminitens* and the harpagones are more acute apically. Harpagones bilobed, as seen from ventral view (fig. 160a), the inner lobe is small, sharply pointed and situated just beneath the large outer lobe; this inner lobe is not visible from lateral view (fig. 160b). The posterior lateral margins of the ninth sternum are not produced and the median margin possesses a small U-shaped cleft. Ninth tergum somewhat produced on posterior median margin into a flat topped development (fig. 160d).

Length: body, 3.5-4.6 mm.; wing, 5.5-6.4 mm.

Female genitalia: Eighth sternum over two times as wide as long,

posterior median lobes well developed and rounding (fig. 160c). The ninth tergum is about three times as wide as long, rounding on the sides and with a broad deep cleft on hind margin, the bottom of this cleft is somewhat undulated (fig. 160e).

Length: body, 6-6.7 mm.; wing, 8 mm.

Type locality: Sao Paulo, Cantareira, (Serra) Brazil.

Additional topotypes have been studied.

Type in the United States National Museum.

Plecia (Plecia) pertinens Hardy

(Plate XXXV, figs. 161a-g)

Plecia (Plecia) pertinens Hardy, 1942, Can. Ento. LXXIV, 112-113.

"This species is related to *confusa* Loew in having the rostrum shorter than the head and thorax entirely yellowish to orange-red and possesses only minor differences other than those of the male genitalia. The antennae of the male are nine segmented, the upper portions of the sternopleurae are pale haired. The fork of the radial sector (vein R_{3+4}) slightly bent in the middle (figs. 161e, f), not so nearly straight as in *confusa*. Vein R_{1+2} ending about half way between the end of the subcostal vein and R_{3+4} not ending close to this vein as in *confusa*. In the allotype the bend in R_{3+4} is closer to the base of the vein and R_{1+2} is still more remote from this vein (fig. 161f).

"*Male genitalia:* Ninth sternum wider than long, posterior lateral margins developed into two rather strong lobes (fig. 161a), with a convexity in the depression. Harpagones very small and undeveloped appearing rather obtuse from a ventral view. From a lateral view the harpagones are developed into a small point on inner apices (fig. 161c). Ninth tergum concave on posterior margin with a heavily sclerotized, blunt protuberance in the middle (fig. 161b).

"Male length: body, 5.3 mm.; wing, 6 mm.

"*Female genitalia:* Eighth sternum with a U-shaped cleft extending two-thirds the length of the segment, posterior median lobes well developed and rounding, outside of these and extending dorsally in toward the genital chamber are a pair of long, slender lobes (fig. 161d), these probably serve as egg guides. The ninth tergum is twice as wide as its greatest length with a broadly V-shaped cleft extending three-fourths its length on hind margin (fig. 161g).

"Female length: body, 6.5 mm.; wing, 7.5-8 mm."

Type locality: Venta de Zopilote, Guerrero, Mex., 2800 ft., Oct.

Type to be returned to the British Museum of Natural History. At present in the Snow Entomological Collection.

The species has also been recorded from State of Colima, Mexico. Guatemala City and Moca, Guatemala. Also from Tegucigalpa, Honduras.

Plecia (*Rhinoplecia*) *pictipennis* Edwards

(Plate XXXV, figs. 162a-c)

Plecia pictipennis Edwards, 1931, Ann. Mag. Nat. Hist. Ser. 10, V. VII, 260.

This species is easily distinguished by its wing markings, the following is the original description:

"*Head* dark grey, heavily pruinose. Antennae black (damaged in all specimens). Mouth-parts black shorter than head, but bent back beneath head as in other species of the subgenus *Rhinoplecia*. *Thorax* with ground-colour dark ochreous-grey, heavily pruinose. Mesonotum with three conspicuous shining black stripes, middle stripe divided by a narrow dull grey line. *Abdomen* dull black. Hypopygium of male mainly formed of the large sternite, which extends even to the dorsal surface; tergite small, quadrate, with one shining black triangular projection in middle. *Legs* short and stout, dark reddish brown, tip of tibiae and tarsi blackened; hind femora much thickened on apical half. *Wings* smoky, scarcely darker towards costa except on stigma. A conspicuous pale yellow fascia across middle of wing from R_1 to tip of Cu_2, broadening out towards base of wing at m-cu, and just extending into lower basal cell; another pale yellow area at base of anal cell, including the angle. Halteres with ochreous stem and black knob.

"Length of body 5-5.5 mm.; wing, 6.5-7.5 mm."

The following description of the male genitalia should be added to this: Ninth sternum very broad, the lateral margins curving around and meeting the ninth tergum on the dorsal side of the segment, occupying as much of the dorsum as the short tergum (fig. 162c). This is the only time the writer has observed this character. Posterior lateral margins of sternum densely matted with short black hair, median portion strongly convex. Harpagones very irregular and appearing somewhat flat topped from ventral view and acutely pointed apically from a lateral view (figs. 162a, b). Because of the irregularity of this structure it is possible to see different perspectives than the ones shown in the figures, depending on the particular angle from which it is viewed. Ninth tergum very small compared with the sternum. The lateral margins of the sternum occupying about one-half the area normally covered by the

tergum. Tergum developed into an acute heavily sclerotized point medianly on posterior margins (fig. 162c). Lateral margins densely haired.

Type locality: Brazil, Castro, Parana.

The writer has examined a paratype male from the British Museum.

Plecia pictipennis var. *rufovittata* Edwards

Plecia (Rhinoplecia) pictipennis rufovittatus Edwards, 1938, Ann. Mag. Nat. Hist. Ser. 11, No. 10, 323.

This differs from the typical variety in having the stripes of the dorsum reddish instead of black.

Specimens have been examined from the type locality, Nova Teutonia, Brazil. Type in British Museum.

Plecia (Plecia) plagiata Wiedemann

(Plate XXXV, figs. 163a-d)

Plecia plagiata Wiedemann, 1824, Analecta Entom. p. 11.
Plecia funebris Fabricius?, 1805, Syst. Antl. 54, 14.
Plecia heteroptera Macquart, 1845, Dipt. Exot. Supl. 1, Mem. del. Soc. Roy. De Lille.
Plecia vittata Bellardi (nec Wiedemann), 1862, Ditt. Mess., Turino App. 7, 4. *P. bellardi* Townsend, 1912, Can. Ento. 44, 289. (?)

The type of *funebris* has been lost and the original description is inadequate but it is probably the same as *plagiata* Wiedemann, but as the identity of the latter is more positive it is better to use this name.

Townsend states that he believes Schiner's synonymy is incorrect and that *vittata* Bellardi is distinct and as that name was preoccupied by Wiedemann's *vittata* he proposes the new name *bellardi*. He gives no specific reason for his assumption except "there is no brownish tinge to the wings, which vary from a dense to a dilute black, with an iridescent greenish to violent reflection in oblique lights. Wiedemann describes the darker parts of the wings of *plagiata* as blackish brown. Schiner gives no reason whatever for placing *vittata* Bell, as a synonym of *plagiata*." The variations in the wing fumosity have been seen to cover the characteristics given by Townsend. The writer has attempted to obtain a specimen of Townsend's series, but the late Doctor E. P. Van Duzee stated in correspondence: "The Diptera in the California Academy of Science collection were destroyed by the San Francisco fire, following the earthquake and were lost."

P. plagiata is an easily distinguished species with a wide range of distribution in the Neotropical region.

MALE and FEMALE.—Entirely black species. *Head:* Rostrum produced but much shorter than the head or antennae. Antennae of male ten-segmented, that of female eleven. Palpi equal to antennae in length. *Thorax:* Entirely opaque black. Mesonotum with two rather deep longitudinal furrows and no apparent median furrow. Notum with sparse recumbent yellow pile. Pleurae chiefly bare except for the brownish hairs on the upper half of sternopleurae. Legs and abdomen densely covered with black pile. *Wings:* With dark brown bands along the veins, leaving the inner portions of most of the cells hyaline. The costal, subcostal and cell R_1 entirely brown. Radial cell (first basal) brown except for a small hyaline spot at the base; all other cells have a clear area in the center. Fork of third vein (R_{3+4}) arising almost vertically into the costa, merging with R_{1+2} at its tip. *Male genitalia:* Posterior lateral margins of ninth sternum greatly produced. Hind margin with two developments. Harpagones long and slender (fig. 163a), folding down into the genital cavity in normal position. Ninth tergum deeply concave, almost separated into two parts, without a central toothlike process (fig. 163b).

Female genitalia: Eighth sternum almost completely divided by a median cleft, only a narrow sclerotized bridge joins the two on anterior edge. The posterior margins are produced into a pair of rounded lobes, at the outer base of each of these is a shallow depressed area (fig. 163c). Ninth tergum three times as wide as its longest portion; with a deep, broadly U-shaped concavity on hind margin (fig. 163d). Cerci almost oval, densely haired.

Length: body, 6-7 mm.; wing, 7-9.3 mm.

Described from Brazil; type in Copenhagen.

Two specimens from type series have been examined. The species is very abundant in the American tropics, having been examined from the following areas: Brazil, British Guiana, Colombia, Costa Rica, Dutch Guiana, Honduras, Mexico, Panama, Peru, and Venezuela. Edwards also records this from Nicaragua and Guatemala.

Plecia (Rhinoplecia) pruinosa Hardy

(Plate XXXV, figs. 164a-b)

Plecia pruinosa Hardy, 1940, Journ. Kan. Ent. Soc. 13, 22-23.

This species is related to *grisea* Edwards but the distinctive genital structures of the male will distinguish it from all known species. The rostrum is more elongate than in *grisea*, the femora are pale basally, halteres are black and the wings smoky brown fumose. Following is the original description of the male genitalia:

"*Genitalia:* Posterior margin of ninth sternum developed into a pair of heavily sclerotized, outward projecting, clasper-like lobes and a pair of smaller, rounded lobes on posterior lateral margins. Harpagones comparatively small and situated toward the middle of the sternum, scarcely visible from ventral view, arising from behind the membranous area and with two acute points apically (fig. 164a). Tergum with a V-shaped excavation in the middle of the hind margin, two obtuse points curving inwardly at apex of tergum (fig. 164b); the hind margin is developed into a broad strongly sclerotized shelf-like area extending into the genital chamber, probably giving support to the anal area."

Length: body, 4.5 mm.; wing, 5.2 mm.

"*Female.*—The scape, pedicle and bases of first flagellar segments are yellow; the entire thorax is faintly yellowish tinged, the margins and humeral ridges are distinctly yellow, as are the trochanters and femora; otherwise like the male.

Length: body, 4.6 mm.; wing, 5.6 mm."

Type locality: Pico Turquino, Cuba.

Type in Cambridge Museum of Comparative Zoölogy.

Plecia (*Rhinoplecia*) *punctulata* Hardy

(Plate XXXV, figs. 165a-b)

Plecia punctulata Hardy, 1940, Journ. Kan. Ent. Soc. 13, 23-24.

Following is the original description:

"Somewhat related to *nitidipes* Edwards but differing in a great many respects. The rostrum is developed as long or longer than the antennae; the dorsum is covered with minute punctules; the ninth sternum is not developed into two pairs of lobes on hind margin and the posterior lateral margins not at all produced; the tergum is not so deeply concave and the lateral margins are developed into a pair of narrow lobes posteriorly (fig. 165a).

"*Male.*—In addition to the characters given above: Entirely black, opaque to subopaque, dorsum sometimes in part shining and usually appearing faintly pruinose, especially on the margins. This appearance is caused by the finely punctulate texture. Stems of halteres yellow-brown, knobs brown to black. *Wings:* yellow-brown fumose, veins and stigma brown; vein R_{2+3} (R_{3+4}) gently curved into the costa; crossvein r-m situated at about the middle of the distance between m-cu and fork of media.

"*Genitalia:* Ninth sternum scarcely developed on hind margin, only two small swellings toward the middle. Harpagones elongate and strong, produced about as long as the sternum and rather

abruptly tapering on the inner margins near their apices (fig. 165e). Ninth tergum divided into two halves by a median groove or invaginated area; posterior lateral margins produced into a pair of narrow lobes; median margin with a strong pointed process (fig. 165a) which folds inward toward the genital chamber.

"Length: body, 3.2-3.6 mm.; wing, 3.7-4 mm.

"*Female.*—The stigma is concolorous with the wing membrane, vein R_{2+3} (R_{3+4}) more oblique, curved but slightly near its base; antennae eleven segmented; humeral ridges and hind margins of mesonotum tinged with rufous; otherwise like the male, except for sexual characters.

"Length: body, 4-4.3 mm.; wing, 4.6-5 mm."

Type locality: Diamantina, Minas Geraes, Brazil.

Type in Cornell University Collection.

Plecia (Rhinoplecia) quadrivittata Williston

(Plate XXXVI, figs. 166a-e)

Plecia quadrivittata Williston, 1900, Bio. Cent. Amer. III, Suppl. I.

This appears to be a rather common species in the states of Guerrero and Colima in Mexico. The writer has examined a large series which fits the original description. Williston's description is very complete with the exception of the male genitalia. The original is quoted: "*Male.* Black throughout. Head lightly gray-pollinose; face prolonged in front of the eyes about as far as the vertex projects backwards; eyes elongate oval, the ocellar tubercle prominent. Thorax and scutellum lightly dusted with grayish, opaque, the mesonotum with four shining black stripes, the lateral ones abbreviated in front, the narrowly separated median ones behind. Abdomen moderately shining. Wings uniformly brown; the anterior branch of the third vein is at an angle of about forty-five degrees, arising nearly opposite the end of the second vein and terminating in the costa a little less than its own length from the tip of the second vein; penultimate section of the third vein a little longer than the length of the anterior cross-vein; furcation broad in the margin; anal cell wide open. Proboscis longer than the distance from the vertex to the lower end of the face. Length 6-7 millim.

"*Female.* Larger; abdomen opaque brownish-black."

Male genitalia: Ninth sternum with a blunt median process on hind margin, posterior lateral margins moderately produced. Harpagones simple, folded inward in normal position, rather acutely pointed (fig. 166b). Accessory structures of aedeagus rather complex (fig. 166c). Ninth tergum cleft about one-half the length of

the segment, the lower portion of the cleft is very narrow (fig. 166d).

Female genitalia: Eighth sternum broad, heavily sclerotized on posterior portion, more lightly so on anterior half. Posterior margin produced into two strong lobes near middle, with two small median developments between and a large rounding swelling at each side (fig. 166a); sternum divided into two plates by the median cleft. Ninth tergum concave on hind margin, posterior lateral margins rounding. Anterior lateral margins strongly produced into a long sclerotized process which extends beneath the eighth abdominal tergum (fig. 166e).

The species was described from Rincon, Guerrero.

The writer has examined a large series from Cuernavaca, Mexico, Oct. 22, 1922 (E. G. Smyth), and Colima, Vulcano, Mexico (L. Conrad).

Cotypes in British Museum collection and American Museum.

Plecia (*Rhinoplecia*) *rectiora* Hardy

(Plate XXXVI, figs. 167a-c)

Plecia (*Rhinoplecia*) *rectiora* Hardy, 1942, Can. Ento. LXXIV, 113.

"The mouthparts of this species are intermediate between *P. confusa* Loew and *rufithorax* Walker. They are about equal to the antennae in length, the mesonotum is only faintly furrowed and the legs and abdomen are brown with a faint reddish tinge. The species, however, can be separated conveniently only by using the male genitalia; these structures differ from any other species in the complex.

"*Genitalia:* Ninth sternum more strongly produced on the posterior lateral margins, these lobes extend beyond the median edge of the segment about three-fourths the length of the harpago. Harpagones simple, pointed apically (fig. 167a); accessory plates at each side of aedeagus large and well developed, each with a strong outward projecting spine on outer margin near apex (fig. 167b) as seen in end view. Ninth tergum with a broad flat bottomed excavation on the hind margin, this cleft has a very minute niche in middle as seen from dorsal view (fig. 167c). The hind margin of the tergum is folded over into the genital chamber, broadly produced, rounded on the sides and developed into an inward projecting point from end view.

"Length: body, 5.5-6 mm.; wing, 7.4 mm.

"Females are slightly larger in size, body, 7-7.4 mm.; wing, 9-10 mm."

Type locality: S. Luiz Ricamar, Est Maranhao, Brazil.

Type in Snow Entomological Collection.

The species has also been recorded from Sapucay and Villarica, Paraguay.

Plecia (Rhinoplecia) rostellata Loew

(Plate XXXVI, figs. 168a-d)

Plecia rostellata Loew, 1858, Berl. Ent. Zeit. II.

Plecia rostrata Bellardi, 1859, Ditt. Mess. 1, 15, 3. (Syn. by Schiner).

The specimens described here fit the original description and the wing figured by Loew and no doubt belong to the species he had in mind. The description of the species was based upon the female so it is difficult to be absolutely sure of its identity, this is the only Brazilian form known to the writer which conforms entirely to Loew's description.

MALE.—*Head:* Rostrum produced as long as the head, longer than the antennae; antennae eight segmented, yellowish with a light brown tinge toward the apical segments; the segments are porportioned as in most other members of the genus. *Thorax:* Entirely yellowish orange; halteres yellowish at their bases, black at their tips. Legs and abdomen brown to black with dense short black hairs. *Wings:* Yellow-brown fumose, costal cell and stigma brown. Fork of radial sector (vein R_{3+4}) arising at end of R_{1+2} and extending almost vertically into the costa. Fork of media located at about one-third the distance from the r-m crossvein to the fork of the Rs. *Genitalia:* Ninth sternum with a convex rounded projection in the middle on the hind margin, posterior lateral margins rather strongly developed but much less than one-half the height of the claspers. Harpagones broad and rather blunt from a ventral view (fig. 168c). Ninth tergum deeply but gently concave on posterior margin; tergum widest at upper one-fourth of the segment (fig. 168d); hind margin not developed as in *gibbosa* Hardy.

Length: body, 6-6.5 mm.; wing, 7-7.5 mm.

FEMALE.—Fits the description of the male (aside from sexual characters) with the exception of the eleven segmented antennae (counting nipplelike tip); the antennae are also darker brown and the specimens are larger. *Female genitalia:* Eighth sternum divided into two plates by median cleft, posterior median lobes rounding and slightly convergent; lateral lobes acutely pointed and arising very close to median lobes; sternum much wider than long (fig. 168a). Ninth tergum deeply cleft on hind margin, this cleft is flat

bottomed and the lateral lobes are broad and rounding; anterior lateral margins produced inwardly into a pair of long projections (fig. 168b).

Length: body, 6.5-7 mm.; wing, 8.5-9.5 mm.

Type locality: Brazil.

Type probably in the Zoölogical Museum at Berlin.

Specimens have been examined from Rio de Janeiro, Brazil, L. Trav., May, 1935 (Lopes), and June 20, 1918 (R. Flacher); Diamantina, State of Minas Geraes, Brazil, Nov. 14-18, 1919 (Cornell University Exped.) and Aqua Preta, Bahia, Brazil, 12-8-39 (Pedrito Silva).

Plecia (*Rhinoplecia*) *rufimarginata* Hardy

(Plate XXXVI, figs. 169a-b)

Plecia rufimarginata Hardy, 1940, Journ. Kan. Ent. Soc. 13, 24.

This species is related to *edwardsi* Hardy but the rostrum is as long as the antennae and the male genitalia are very different. The pleurae, margins of mesonotum and legs of both sexes are lightly yellowish tinged. The fork of media is at about half the distance between r-m crossvein and fork of Rs, instead of near basal third as in *edwardsi*. This is the smallest *Plecia* known to the writer. Following is the original description of the male genitalia:

"*Male genitalia:* Ninth sternum slightly wider than long, posterior margin concave, with three median projections; the two lateral ones are heavily sclerotized, vertical in position and densely haired; the median is more membranous and projects inward toward the genital chamber and is bare (fig. 169b). The harpagones are simple and terminate in an acute point on the inner margins. Ninth tergum with but a single concavity on posterior margin (fig. 169a)."

Male length: body, 2.1-2.3 mm.; wings, 2.6 mm.

Female length: body, 2.6-2.7 mm.; wings, 3.2 mm.

Type locality: Paraiso, Panama.

Type in the United States National Museum Collection.

Plecia (*Rhinoplecia*) *rufiscutella* Hardy

(Plate XXXVI, figs. 170a-b)

Plecia rufiscutella Hardy, 1940, Journ. Kan. Ent. Soc. 13; 24-25.

The male genitalia places this species near *nitidipes* Edwards. It is easily recognized by the bright orange-red scutellum of both sexes. The rostrum is more elongate, the wings differ and the genital characters are distinct from *nitidipes*. Following is the original description:

"*Male.—Head:* Rostrum produced longer than the head, antennae broken on holotype specimen. *Thorax:* Opaque black with a faint reddish tinge on the lateral margins; scutellum bright orange-red. Almost bare species, with only brown hairs on the upper portions of the sternopleurae and a dense patch of black hair on each humerus. Mesonotal furrows very faint, sides and hind portions of notum rugose; the rugosity appearing in sunken areas, one on each side and one just before the scutellum. Legs and abdomen subshining black with black pile; halteres black. *Wings:* The wing venation is much the same as in *plagiata* Wiedemann but the fumose borders of the veins are more yellow and not so dark. Vein R_{2+3} (R_{3+4}) gently curves into the costa. R_1 is situated two-thirds the distance between subcosta and R_{2+3} (R_{3+4}); fork of media at or slightly beyond one-half the distance from the r-m crossvein to the fork of Rs.

"*Genitalia:* Ninth sternum very broad and rather long, posterior lateral margins produced into two large flat-topped lobes, posterior median margin with two narrow processes. Harpagones very slender and elongate, vertical in position (fig. 170b). Ninth tergum concave on hind margin, posterior lateral margins with a distinct emargination, anterior margin very deeply cut inward almost dividing the segment (fig. 170a); cerci very broad and rounding.

"Length: body, 7.5 mm.; wing, 9.5 mm."

"*Female.*—Antennae eleven segmented, thorax brownish with a faint shade of red; scutellum yellow-orange; legs slightly reddish tinged, otherwise like the male.

"Length: body, 8-9 mm.; wing, 12 mm."

Type locality: Moyombamba Region, Peru.

Type in the American Museum.

Plecia (Rhinoplecia) rufithorax Walker

(Plate XXXVI, figs. 171a-d)

Plecia rufithorax Walker, 1848, List of Dipt. in Brit. Mus. I. 116.

This species has also caused a great deal of controversy in that it has long been common practice to place almost all Neotropical *Plecia* of medium size, long rostrum and rufous thorax under this name. Walker's type was a female from Jamaica and all the males the writer has examined from this island have been conspecific. Doctor Edwards has also compared females with the type, so the species here described is no doubt *rufithorax*.

MALE.—*Head:* Rostrum produced as long as the head and longer than the antennae, antennae eight segmented; the pedicel, scape and basal one-half of first flagellar segment yellow, otherwise brownish

yellow; ocellar tubercle very prominent. *Thorax:* Entirely yellowish to orange-rufous. Mesonotum sometimes lightly speckled with brownish; notum with two distinct longitudinal furrows, and one faint median furrow, the lateral ones converge slightly before the scutellum. Halteres with brown knobs and yellow stems. Legs and abdomen brown to black with black hairs. *Wings:* Brownish yellow fumose, stigma but little darker than the membrane, veins brown. Fork of radial sector (vein R_{3+4}) arising just beyond the end of R_{1+2} and extending almost vertically into the wing margin (fig. 171c). Fork of M_1 and $_2$ at about basal one-third of distance between the radio-medial crossvein and the fork of the radial sector. *Genitalia:* Ninth sternum slightly broader than long with a median process on hind margin, this process terminates in two small lateral projections with a small depressed area between. Posterior lateral margins of sternum only slightly developed. Harpagones broad and flat apically ending in two points (fig. 172a). Ninth tergum with an almost rectilinear excavation on hind margin, the sides and bottom of this area but slightly rounded (fig. 171b).

Length: body, 4.6-5.4 mm.; wing, 5.5-6 mm.

Female genitalia: Ninth tergum about three times as wide as long with a broadly U-shaped cleft on hind margin and a slight convexity in the middle of this cleft; posterior lateral margins somewhat undulated (fig. 171a). Eighth sternum divided into two plates by a median cleft, median lobes elongated and pointed apically, posterior lateral margins wavy, lateral lobes rounded (fig. 171d).

Female length: body, 5.5 mm.; wing, 6-6.7 mm.

Described from the Island of Jamaica.

Type in British Museum.

The writer has studied specimens from the type locality .

Plecia rufithorax concava Hardy

(Plate XXXVII, figs. 172a-f)

Plecia rufithorax concava Hardy, 1942, Can. Ento. LXXIV, 114.

"The specimens here discussed are considered a subspecies of *rufithorax* because of the apparent close relationship shown in the genital structures of both sexes. The males differ chiefly in having the ninth tergum moderately concave, broadly U-shaped on hind margin (fig. 172d). The ninth sternum and harpagones appear to be identical (fig. 172a). The female genitalia show considerably more differentiation than those of the male. The cleft of ninth tergum is broadly U-shaped on hind margin (fig. 172e) instead of being wide and flat bottomed as in typical *rufithorax* and the posterior

lateral margins of the tergum are broadly rounded, not indented. The tergum is almost twice as wide as long. Eighth sternum developed into two prominent lobes near middle on hind margin, these are characteristically notched on their outer margins (fig. 172f). Specimens of both sexes are also of larger size than the typical *rufithorax,* the female of *concava* being almost twice as large.

"Length: male body, 6 mm.; wing, 6.7-8 mm.

"Female: body, 7.4-8.6 mm.; wing, 9.4-10.7 mm."

Type locality: * Holotype male and allotype female on same pin, Cacao Trece Aguas, Alta V. Paz, Guatemala, Aug. 4, '06 (Schwarz-Barber.) Paratypes: One female, same data; one male Cayuga, Guat., April 1915 (Wm. Schaus); one male, one female, Orizaba, Mexico (Mann); four males, one female, Tegucigalpa, Honduras, April-June, 1917-18 (F. J. Dyer); one male, same locality, June 6, 1909; one female, La Cieba, Brit. Honduras, Oct. 18, 1916 (F. J. Dyer); one male, Rep. Honduras, Tabasco, 15 April, 1924 (C. H. Curran); one female, Prieta, Rep. Hond., 6 Apr., '24 (J. Bequaert); and one male, one female, Claremont, Jamaica, March 10, 1931 (E. L. Bell).

Type in United States National Museum.

Plecia (*Rhinoplecia*) *rugosa* Hardy

(Plate XXXVII, figs. 173a-c)

Plecia rugosa Hardy, 1940, Journ. Kan. Ent. Soc. 13, 25-27.

Following is the original description:

"This species seems to approach *rufimarginata* Hardy in general characters but is easily separated by the finely shagreened surface of the mesonotum, its slightly larger size and very different genitalia.

"*Male.—Head:* Rostrum produced about as long as antennae, folded beneath the face. Antennae nine segmented, the segments short and compressed. *Thorax:* Mesonotum shining, entire surface finely shagreened, somewhat more coarsely so on the lateral and anterior margins, more smooth posteriorly. Mesonotal furrows very distinct, terminating in a small depressed area just before the scutellum. Dorsum almost bare, a few scattered yellow hairs on the margin of the notum. Pleurae chiefly opaque, upper portions of sternopleurae also shagreened, with numerous long brown hairs; lower portions of sternopleurae shining and bare. Halteres black, stems yellow-brown. Legs and abdomen dark brown to black, covered with long black pile, tarsal joints slender. *Wings:* Uniformly yellow-

* The type localities were left out of the original description, so these are recorded here

brown fumose, stigma but little darker than membrane, veins brown. Fork of third vein, R_{2+3} (R_{3+4}), curved moderately into the costa; fork of media situated just before one-half the distance from r-m crossvein to the fork of the radial sector. Vein Cu_2 (Cu_1) scarcely sloped downward at its tip, anal cell as wide at apex as at middle.

"*Genitalia:* Ninth sternum broader than long, posterior lateral margins not developed; hind margin with two moderately developed erections having a U-shaped concavity between them; median portion developed into a somewhat membranous area which fits above the aedeagus. Harpagones with a somewhat beaklike point apically, on inner side (fig. 173a). Ninth tergum about as long as wide, narrowing somewhat on apical one-third, hind margin with a small indentation (fig. 173b); hind margin of tergum developed inwardly to form a broad plate before the anal region, as seen from lateral or end view; this plate terminates in two strongly sclerotized, inward projecting points (fig. 173c).

"Length: body, 3-3.3 mm.; wing, 3.5 mm.

"*Female.*—Differs from the male in having the thorax entirely rufous and abdominal sterna lightly tinged with yellowish and first two abdominal segments yellow.

"Length: body, 4.5 mm.; wing, 4.6 mm."

Type locality: Bet. Queremal and Buenaventura, Columbia.

Type in the American Museum Collection.

Plecia (Rhinoplecia) seminitens Edwards

(Plate XXXVII, figs. 174a-c)

Plecia seminitens Edwards, 1938, Ann. Mag. Nat. Hist. Ser. II, V. 2, 321-322.

The following is the original description of the male:

"Male. Black, only stem of halteres and base of femora brownish. Eyes bare, undivided and without any obviously differentiated lower area of smaller facets. Mouth-parts and clypeus folded back under head as usual in this subgenus, but not noticeably elongate; palpi shortish, each of the four segments very little longer than broad. Antennal flagellum short, 6-segmented, terminal segment the largest. Mesonotum with three brightly shining stripes; shoulders and front ends of a pair of narrow deep grooves between the stripes with coarse gray dusting; median stripe not obviously grooved down the middle; similar coarse gray dusting on most of pleurae, but lower half of sternopleurae shining black; a small patch of hair in middle of sternopleurae, pteropleura bare. Abdomen shining. Femora somewhat clubbed on distal half; hind tibiae slightly and uniformly

thickened. Wings with uniform dark smoky tint; R_4 short and vertical. Hypopygium: tergite pubescent, posterior margin nearly straight, in middle with a small bare shining black triangular process which is curved inwards; styles large and lateral in position, divided distally into two lobes, the upper lobe broad, flat and rounded, the lower small, narrow and thumb-like. Length of body or wing 4 mm."

The writer has studied a metatype male and makes the following addition to the description: Ninth sternum with a broad flat topped median process on hind margin; inner lobe of harpagones projecting at about level or slightly above the outer lobe from ventral view (fig. 174a), narrower and slightly longer than the thick outer lobe; harpagones broad from lateral view, with both lobes visible (fig. 174b), although the outer (stronger) lobe folds inward making it necessary to tilt the structure in order to view it. Median process of ninth tergum scarcely produced beyond posterior margin of the segment (fig. 174c), and flat topped in the specimen studied.

Doctor Edwards stated (in correspondence) that he felt quite sure the female described as *seminitens* belongs to a different species, however, it is possible that they are correctly associated as several dimorphic species have been found in this group, so the description is quoted here: "Female (?). Resembles the male in most respects, notably its small size, shining black lower half of sternopleura and almost uniformly dark wings, but differs as follows:—Mouth-parts even shorter. Antennal flagellum dark brownish, 8-segmented (apart from the nipple-like tip). Mesonotum wholly light reddish. R_4 more oblique. Length of body or wing 5 mm."

Type locality: Nova Teutonia, Brazil.

Type in the British Museum.

The writer has studied a topotype.

Plecia (*Rhinoplecia*) *serrata* Hardy

(Plate XXXVII, figs. 175a-c)

Plecia (*Rhinoplecia*) *serrata* Hardy, 1942, Can. Ento. LXXIV, 114.

"This species is related to *vittata* Wiedemann and *bicolor* Bellardi but separates from all other members of this genus by its unique genitalia.

"MALE.—Antennae nine segmented, the terminal segments small and nipplelike. Rostrum as long as the head, longer than the antennae. Pleurae brown to black with a faint rufous tinge. Dorsum entirely rufous, halteres black. Legs chiefly black, bases

of femora somewhat yellowish. Wings smoky fumose, vein R_{3+4} almost vertical, but slightly curved into the costa. Fork of veins M_1 and $_2$ situated at about the basal one-third of the distance from the radio-medial crossvein to the fork of the radial sector. Stigma concolorous with the membrane. *Genitalia:* Ninth sternum with a pair of pointed lobes on the posterior margin in the middle, posterior lateral margins of sternum not developed. Harpagones strong, very broad, with numerous small pointed teeth on the inner apical edges, as seen from the ventral view (fig. 175a), almost square topped from a lateral view (fig. 175b). Ninth tergum with a small concavity medianly on the hind margin (fig. 175c).

"Length: body, 4 mm.; wing, 4.7 mm.

"Female unknown."

Type locality: Villarica, Paraguay.

Type at Michigan State College.

Plecia (*Rhinoplecia*) *similis* Rondani

(Plate XXXVII, figs. 176a-c)

Plecia similis Rondani, 1850, Nuovi Ann. Delle. Sci. Nat. Ser. III, tom II, 193.

Plecia minor Jaennicke, 1867, Neue Exot. Dipt. Abhandl, d. Senckenb. Naturl. G. Bd. VI, 318.

The species at hand fits the original description better than any other Brazilian species and all of the specimens examined from the type locality have been the same. This is also the species which is considered *similis* in the British Museum.

Entirely black species. *Head:* Rostrum strongly produced, longer than the antennae in both sexes. Antennae nine segmented in the male, eleven segmented in the female, the latter more compacted. *Thorax:* Dorsum faintly shining with three longitudinal furrows down the middle, the median groove weak. Pleurae opaque, lower half of sternopleurae faintly shining, upper portion of sternopleurae with sparse pale hair. Wings subhyaline, basal and costal portion lightly fumose. Fork of third vein (R_{3+4}) curved into costa; fork of M_1 and $_2$ situated just before one-half the distance between the r-m crossvein and the fork of the radial sector. *Male genitalia:* Ninth sternum longer than wide with a well developed median process on the hind margin, this development is bifid apically. Harpagones broad and blunt, especially from a ventral view (fig. 176a). From a lateral view a blunt arm projects inward slightly on outer margin, from this view a large hollowed out area can be seen in the center (fig. 176b). Ninth tergum concave on posterior

margin with a somewhat membranous development in the center (fig. 176c).

Male length: body, 4.5-5 mm.; wing, 5-6 mm.

Female length: body, 5.5-6 mm.; wing, 7 mm.

Type locality: San Sebastian.

Type probably at the University of Bologna.

Specimens have been examined from S. Jose Cos. Campos., July, 1933 (H. S. Lopes); Brazil, S. Paulo Est. S. Paulo, July 9, 1928; Ctr. Brazil, Oct. 22, 1924 (Flacher); and Toinville, Brazil (Lichtwardt).

Plecia (*Rhinoplecia*) *trilobata* Hardy

(Plate XXXVII, figs. 177a-d)

Pleca (*Rhinoplecia*) *trilobata* Hardy, 1942, Can. Ento. LXXIV, 114-115.

"This species is near *bicolor* Bellardi but the male genitalia are so distinctive that its identity can not be mistaken. The antennae are distinctly yellowed in this species and the pleurae are somewhat tinged with rufescent. These characters alone, however, would not separate it conveniently.

"MALE.—Antennae nine segmented, counting knoblike tip. Rostrum produced slightly longer than the antenae. Compound eyes divided by a shallow furrow on lower one-third. Wings comparatively short, about equal to the length of body, vein R_{3+4} gently curved. Hind tarsi somewhat swollen, subsegments short. *Male genitalia*: Ninth sternum rather elongate compared with its width, its posterior margin undulated (fig. 177a). Harpagones three lobed, two arms visible from ventral view, the third only seen from lateral. Dorsal arms long and curved, median arms small with two apical points; ventral lobes large and rounding, the surface densely pitted (fig. 177b). Ninth tergum broad, with a small V-shaped concavity from a direct dorsal view (fig. 177c); the inner top edge of the segment is developed inward into a broad flat area and two sharp points (fig. 177d); this can only be seen by looking directly down into the genital chamber.

"Length: body, and wings, 4.7-5 mm.

"FEMALE.—Antennae eleven segmented; bases of femora somewhat yellowed; pleurae more rufous tinged, all tarsi slender.

"Length: body, 5.8 mm.; wing, 6.4 mm."

Type locality: British Guiana, Upper Courantyne R., King Frederick William IV Falls.

Type to be returned to the British Museum.

Plecia (*Rhinoplecia*) *uberta* Hardy

(Plate XXXVII, figs. 178a-e)

Plecia (*Rhinoplecia*) *uberta* Hardy, 1942, Can. Ento. LXXIV, 115.

"This species is related to *collaris* by having the anterior portion of the dorsum blackish, it is distinguished by its small, acutely pointed harpagones, small median development on the hind margin of the ninth sternum and the V-shaped cleft of the posterior margin of ninth tergum.

"MALE.—*Head:* Rostrum well developed, as long as the head and longer than the antennae. Antennae eight segmented, slightly yellowish tinged, most segments longer than wide and rather loosely joined. Compound eyes not divided by a transverse depression. *Thorax:* Mesonotum and scutellum chiefly rufous, anterior portion of dorsum black. Pleurae yellow-brown to blackish; humeral ridges largely yellow; halteres black, stems pale. All tarsi slender, posterior basitarsi not at all swollen, equal in length to the next four subsegments. *Wings:* Brownish yellow fumose, stigma slightly darker than the membrane. Anterior fork of Rs (R_{3+4}) straight and almost vertical. Cubital cell widely open in the wing margin. *Genitalia:* Ninth sternum with a blunt median projection on the posterior margin, lateral margins not developed. Harpagones small, slender and rather sharply pointed (fig. 178c), folded downward in normal position, scarcely visible from ventral view unless plate is tilted back (fig. 178a). Ninth tergum broader than long with a deep V-shaped concavity on posterior margin (fig. 178b).

"Length: body, 6-6.5 mm.; wing, 7.5-8 mm."

Type locality: Lombardia, Honduras.

Type in United States National Museum.

This species has also been reported from Motzorongo, V. C., Cordoba and Teapa, Tabasco, Mexico.

Plecia (*Rhinoplecia*) *varabilis* Hardy

(Plate XXXVIII, figs. 179a-c)

Plecia (*Rhinoplecia*) *varabilis* Hardy, 1942, Can. Ento. LXXIV, 115-116.

"This species can be separated from *rufithorax* Walker only by the male genitalia. It is easily distinguished by the characteristic development of the ninth sternum and the small V-shaped cleft on the hind margin.

"The rostrum is well developed, longer than the antennae and folded beneath the face in resting position, compound eyes without a transverse groove on lower portion. Antennae of male eight seg-

mented, of female ten segmented, antennae as well as pleurae and sides of abdomen often tinged with yellow. *Male genitalia:* Ninth sternum broad; posterior lateral margins strongly developed, reaching much beyond the bases of the harpagones. Hind margin of sternum with a characteristic knoblike development in the middle (fig. 179a). Harpagones well developed, with several irregular teeth or bumps apically (fig. 179b). Ninth tergum but little wider than long, hind margin with a small V-shaped excavation in the middle (fig. 179c).

"The specimens in the type series show considerable variation in color, the typical coloration being yellow-orange without maculations, varying from this to dark rufous with irregular dark spots. Some of the female specimens in the series conform with the latter but they appear to be slightly teneral and this is probably not characteristic.

"Length: body, 5-6.7 mm; wing, 5.3-8.6 mm."

Type locality: Barro Colo. Isld., Canal Zone.

Type in American Museum of Natural History.

This species has been recorded from various localities in Panama and Guatemala.

Plecia (*Rhinoplecia*) *vittata* Wiedemann

(Plate XXXVIII, figs. 180a-c)

Plecia vittata Wiedemann, 1828, Aus. Zweifl. Ins. I, 75.

The late Doctor Edwards of the British Museum compared specimens with the female type and sent the writer a male specimen from his series; this conformed with a Brazilian species in the writers collection.

This species is related to *bicolor* Bellardi and is best separated from that species by the male genitalia. The wings are clearer than in *bicolor,* the costal area is somewhat smoky near the apices of the wing in males; the legs seem more consistently black and the genitalia more shining, the specimens are also slightly larger.

Male genitalia: Ninth sternum broad and rounded, with a slight inward dip on hind margin. Harpagones very stout and irregular in shape (fig. 180a) somewhat pointed apically but inner margin developed into a large blunt projection, visible from a lateral view (fig. 180b). Hind margin of ninth tergum developed into two obtuse lobes, these fold back slightly toward the anal area. Ninth tergum wider than long (fig. 180c).

The female can be separated from *bicolor* only on size and geographical distribution.

Male length: body, 5-5.5 mm.; wing, 6 mm.

Female length: body, 6.5-7.5 mm.; wing, 8 mm.

Type locality: Brazil.

Type in Berliner Museum.

Specimens have been examined from Brazilien Nova Teutonia, 27° 11′ B. 52° 23° L. 1938 (Fritz Plaumann); M. do Governo, Oct. 31 (J. Melzes) and Rio de Janeiro, Brazil, Oct. 1919 (Cornell Univ. Exped. Lot 569). Edwards also reports it from Santa Catharina, Brazil.

Plecia (*Rhinoplecia*) *xenia* Hardy

(Plate XXXVIII, figs. 181a-e)

Plecia (*Rhinoplecia*) *xenia* Hardy, 1942, Can. Ento. LXXIV, 109-110.

"This is related to *rufithorax* Walker but the male genitalia are very different; the fork of the radial sector (vein R_{3+4}) is somewhat more sharply curved at its middle (near fig. 161e) and the fork of the media arises just before the middle of the distance between the r-m crossvein and the fork of the Rs.

"*Male genitalia:* Posterior lateral margins of the ninth sternum strongly produced, extending almost as long as posterior median margin of sternum; the segment is gradually convex, with a small development in the middle on hind margin (fig. 181d). This is scarcely visible from a ventral view. Harpagones well developed and very irregular in shape, covered with numerous teethlike points and bumps (fig. 181c). Ninth tergum about as high as long, longest in middle, gently convex, with a narrow slitlike invagination medianly on the posterior margin (fig. 181b).

"Male length: body, 4-5 mm.; wing, 4.5-6 mm.

"*Female genitalia:* Eighth sternum twice as wide as long with the posterior lateral margins more elongate than the rounded median lobes (fig. 181e). Ninth tergum about half as long on lateral margins as its width, deeply cleft on both anterior and posterior margins with only a narrow bridge of sclerite joining the lateral plates; lateral plates strongly produced anteriorly (fig. 181a).

"Female length: body 5-6 mm.; wing, 5.5-6 mm."

Type locality: Higuito San Mateo, Costa Rica.

Type in United States National Museum.

The species has also been recorded from San Jose, San Carlos, and Santa Ana, Costa Rica.

Plecia femorata Macquart, 1838, Dipt. Exot. Nouv. ou peu connus, Mem. de la Soc. Sci. Lille i, i, 90. Described from Brazil but cannot be placed.

Bibio Geoffroy

Bibio Geoffroy, 1764, Hist. Ins. V. 2, 571.

The genus is characterized by the development of the tibial spurs and the presence of the radio-medial crossvein separating the third and fourth longitudinal veins (R_5 and M). The subcostal vein is usually well developed and extends to or near the costal margin. The first branch of radius consists of radial veins one to four inclusive fused together, while the posterior branch is interpreted as the fifth radial vein. The comparative length of the r-m crossvein with the length of the basal portion of vein R_5 (Rs) is a very important taxonomic character. The veins beyond radius (so-called posterior veins) are usually lighter in color and are often concolorous with the membrane. The costa ends at or but slightly beyond the end of vein R_5. The antennae are rather short and composed of six to ten short, broad, closely pressed segments; each segment bearing one or two rows of strong hairs in addition to fine pubescence. The eyes of the male are contiguous on the front while those of the female are broadly separated. The femora and tibiae of the males are usually swollen, never long, and slender as in the more primitive genera. In many species the subsegments of the posterior tarsi are greatly dilated.

For the most part the genital structures of the male *Bibio* are not as important taxonomically as in other genera and in many groups the specific characters of the genitalia are very obscure and difficult to differentiate; in some cases no noticeable specific differences appear to be present.

Genotype: *Tipula hortulana* Linn., 1762, Hist. Abregee Ins. Vol. 2, p. 568.

KEY TO SPECIES OF MALE BIBIO

1. Inner spur of front tibiae short, not more than one-half the length of outer..... 2
   Inner spur of front tibiae long, conspicuously more than one-half the length of outer, 9
2. Crossvein r-m one-third to one-fourth the length of basal part of Rs..... 3
   Crossvein r-m at least one-half the length of the basal part of Rs..... 22
3. Legs entirely black or dark brownish red, never rufous..... 4
   At least the tibiae in part yellow; posterior basitarsi scarcely over two times as long as wide 6
4. Posterior basitarsi one-third to one-fourth as wide as long; hind femora averaging 2 mm., hind tibiae 1.8 mm.; smaller species, length of wing 4.5-6.5 mm..... 5
   Posterior basitarsi five to six times as long as wide; hind femora averaging from 2.5-2.9 mm.; hind tibiae 2.4-2.6 mm.; usually larger species, length of wing 6-9 mm. 7
5. Wings dusky to smoky hyaline..... 5a *melanopilosus* Hardy, p. 473
   Wings hyaline to yellowish fumose; pile of dorsum yellow.
   albipennis var. *tenuipes* Coquillett, p. 453

5a. Pile of thorax and legs chiefly black; humeral ridges tinged with yellow. Wing 5-6 mm. ..... *melanopilosus melanopilosus* Hardy, p. 473

Pile of thorax, coxae and femora yellow; humeral ridges black; slightly larger species. Wing 6-6.5 mm. ..... *melanopilosus* var. *biseptus* Hardy, p. 473

6. Femora black, thorax and abdomen mostly black pilose..... *curtipes* James, p. 462
Femora more rufous, abdomen at most gray pilose, thorax with some yellow pile. *kansensis* James, p. 469

7. Wings dusky ..... *albipennis beameri* n. sub. sp., p. 451
Wings hyaline 8

8. Sclerites of abdomen not overlapping. comparatively short, revealing white or gray conjunctiva ..... *conjunctivus* Hardy, p. 460
Sclerites overlapping, conjunctiva black..... 8a *albipennis* Say, p. 451

8a. Pile usually longer and more abundant, especially on males (western). *albipennis hirtus* Loew, p. 452
Pile shorter and less abundant (eastern)..... *albipennis albipennis* Say, p. 451

9. Legs black or dark reddish brown..... 10
Legs rufous or bicolored..... 13

10. Pile of thorax black..... 11
Pile of thorax yellow, or with some yellow pile intermixed..... 12

11. Crossvein r-m one-fourth the length of Rs..... *necotus* Hardy, p. 476
Crossvein r-m equal to the length of Rs..... *criorhinus* Bellardi, p. 462

12. Posterior veins concolorous with membrane; inner spurs of front tibiae nearly equal to the outer ..... *mickeli* Hardy, p. 474
Posterior veins dark; inner spurs of front tibiae shorter, about three-fourths the length of the outer ..... *utahensis* Hardy, p. 489

13. Only femora rufous ..... *femoratus* Wiedemann, p. 463
More of legs yellow to rufous 14

14. Larger species, (wing 7.5-9.5 mm.); pile chiefly dark..... 15
Smaller species (wing 4-6 mm.); pile usually pale..... 17

15. Femora (at least basally) dark brown to black, contrasting in color from posterior tibiae; pile gray to black..... *nervosus* Loew, p. 477
Femora rufous, dark tipped, concolorous with posterior tibiae..... 16

16. Wings chiefly hyaline, posterior basitarsi not enlarged..... *xanthopus* Wiedemann, p. 491
Wings yellowish fumose, posterior basitarsi enlarged..... *velorum* McAtee, p. 490

17. Subsegments of hind tarsi long and slender, metatarsi about seven times as long as wide and about three times as long as inner spurs of hind tibiae (fig. 191a). Posterior veins concolorous with the membrane; dorsum of female rufous. Posterior femora average 2.6 mm. in length, posterior tibiae 2.4 mm..... *fraternus* Loew, p. 465
Subsegments of hind tarsi rather short and thick, metatarsi from two and one-half to four and one-half times as long as wide, scarcely over twice as long as tibial spurs. Posterior veins darker than membrane in most species; dorsum of female black. Posterior femora average 1.7-2 mm. in length, tibiae 1.5-1.7 mm..... 18

18. Posterior veins concolorous with the membrane..... 19
Posterior veins darker than the membrane..... 20

19. Pile of thorax and abdomen chiefly black..... *nigripilus* Loew, p. 480
Pile chiefly yellow ..... *abbreviatus* Loew, p. 450

20. Pile chiefly yellow, legs almost entirely rufous or yellow..... 21
Pile black, legs chiefly reddish brown to black..... *velcidus* Hardy, p. 490

21. Eyes divided into an upper and lower portion by a transverse depressed area just below middle line; wings hyaline or slightly yellow fumose; spurs of posterior tibiae thick and blunt at apex, hind metatarsus not quite three times as long as wide (fig. 188a) ..... *carri* Curran, p. 458
Transverse depression near lower one-fourth of compound eye; wings dusky to smoky; spurs of posterior tibiae more slender and acute, metatarsus four times as long as wide (fig. 195a). (Some atypical specimens will run here). *Knowltoni* var. *paltidus* Hardy, p. 470

22. Posterior basitarsi distinctly enlarged, almost to equally as large as the end of the femora 23
Posterior basitarsi not distinctly swollen 40

23. Legs brown to black, not distinctly bicolored..... 24
Legs distinctly bicolored or entirely yellow to rufous..... 27

24. Thorax and legs entirely dark haired..... *slossonae* Cockerell, p. 486
Thorax and legs pale haired, sometimes with a few scattered black hairs on the dorsum 25

25. Larger species, wing 8.6-9.3 mm.; wings brownish fumose..*rufithorax* Wiedemann, p. 483
Smaller species, wing 4.5-5.5 mm.; wings pale yellow fumose..... 26
26. Stigma dark brown, posterior veins darker than membrane. Posterior basitarsus about three times as long as wide (fig. 196b); all tibial spurs acute; outer spur of front tibiae extending about one-third the length of the basitarsus (fig. 196a), *longipes* Loew, p. 472
Stigma light yellow, posterior veins concolorous with the membrane. Hind basitarsus scarcely over twice as long as wide (fig. 202b); tibial spurs more blunt; outer spur of front tibia half as long as the basitarsus (fig. 202a).....*sericatus* Hardy, p. 484
27. Femora entirely black or very dark; basal constriction never yellow. Stigma obsolete 28
Femora bicolored or entirely rufous..... 29
28. Pile of thorax black. Wings slightly yellowish hyaline.....*monsteri* James, p. 475
Pile of thorax yellow. Wings hyaline.....*labradorensis* Johnson, p. 471
29. Femora chiefly rufous, not more than apices dark..... 33
Basal constriction of femora yellow, otherwise black or dark reddish brown..... 30
30. Pile black ..... *bryanti* var. *nigrita* Curran, p. 457
Pile pale or yellow 31
31. Posterior basitarsi strongly swollen, rather globular, only two and one-half times as long as wide and broader than apices of femora; tibiae strongly dilated; posterior veins darker than membrane .....*flukei* Hardy, p. 464
Posterior basitarsi not greatly dilated, more cylindrical, at least three and one-half times as long as wide; posterior veins concolorous with membrane..... 32
32. Wings whitish or grayish hyaline; femora black apically.....*pingreensis* James, p. 481
Wings dark yellow fumose; apex of femora brown.....*tenellus* Hardy, p. 486
33. Femora entirely yellow to rufous, not tipped..... 38
At least apices of femora narrowly black tipped..... 34
34. Pile black; femora only slightly tipped; wings hyaline.....*bryanti* Johnson, p. 456
At least some yellow pile on dorsum, that of pleurae, coxae and femora always pale, 35
35. Smaller species (wing 4-5 mm.); wings yellowish hyaline, posterior veins darker than membrane .....*fluginatus* Hardy, p. 464
Larger species (wing 7-8.5 mm.); wings yellowish fumose..... 36
36. At least posterior tibiae concolorous with femora, not with a dark brown to black stripe running the entire length; posterior veins concolorous with membrane..... 37
Anterior tibiae dark reddish brown to black, middle tibiae dark reddish to brown, posterior tibiae with dark brown to black strip running the entire length dorsally. Posterior veins yellow-brown .....*columbiaensis* Hardy, p. 459
37. Tibiae, hind femora and basal tarsal joints pale, with dark tips..*inaequalis* Loew, p. 468
Only femora dark tipped .....*fumipennis* Walker, p. 466
38. Larger species, wing 6.5-8.5 mm.; genitalia black..... 39
Smaller species, wing 4.5 mm.; ninth sternum bright yellow, coxae and trochanters yellow .....*townesi* n. sp., p. 487
39. Pile of thorax black; wings hyaline .....*bryanti* Johnson, p. 456
Pile of thorax yellow; wings brownish yellow fumose.....*inaequalis* Loew, p. 468
40. Legs distinctly bicolored or rufous, at least bases of tibiae light colored..... 42
Legs entirely dark 41
41. Legs shining black; wings dark yellow-brown fumose.....*carolinus* Hardy, p. 457
Legs dark reddish brown to black; wings whitish hyaline .....*similis* James, p. 485
42. Only femora rufous .....*holti* McAtee, p. 467
More of legs yellow to rufous..... 43
43. Femora dark brown to black contrasting from paler tibiae, at least bases of tibiae yellow to rufous 44
Femora rufous, not thus contrasting, usually entirely rufous, if darkened apically the tibiae are also darkened 48
44. Larger species, wing 7-8.5 mm..... 45
Smaller species, wing 4-5.5 mm. 47
45. Wings hyaline 46
Wings yellow-brown fumose; sometimes only bases of tibiae yellow rufous, pile dense, yellow. Humeral crossvein obsolete ..... 45a *neojacobi* n. n., p. 476
45a. Only the bases of tibiae yellowish to rufous, legs otherwise black.
neojacobi neojacobi n. n., p. 476
Tibiae, first two tarsal subsegments and bases of femora rufous.
neojacobi rufitibialis Hardy, p. 477

46. Posterior veins concolorous with the membrane; pile dense black..*vestitus* Walker, p. 491
Posterior veins darker than membrane; pile yellow.....*atripilosus* James, p. 455
47. Pile of dorsum long, dense black with yellow hairs intermixed, or pile of dorsum entirely yellow; wings hyaline to dusky. Inner spurs of front tibiae about one-fourth the length of the outer ..... 47a *nigrifemoratus* Hardy, p. 478
Pile very sparse and short, chiefly black; wings yellow fumose. Inner spurs of front tibiae about one-half the length of outer.....*cognatus* Hardy, p. 459
47a. Pile of dorsum chiefly black.....*nigrifemoratus nigrifemoratus* Hardy, p. 478
Pile of dorsum entirely yellow.....*nigrifemoratus* var. *gilvus* Hardy, p. 479
48. Larger species (wing 6-9.5 mm.); posterior basitarsi as long as next two subsegments and five times as long as wide..... 51
Smaller species (wing 4-5 mm.); posterior basitarsi shorter than next two subsegments and less than four times as long as wide..... 49
49. Middle and anterior legs marked with brown, anterior tibiae black basally; dorsum of female black ..... 49a *knowltoni* Hardy, p. 469
Middle and anterior legs concolorous with posterior legs; dorsum of female slightly rufous 50
49a. Wings yellowish .....*knowltoni knowltoni* Hardy, p. 469
Wings dusky .....*knowltoni* var. *paltidus* Hardy, p. 470
50. Tibiae with gray to black pile contrasting with silky yellowish pile of femora; eyes mostly pale pilose .....*alexanderi* James, p. 453
Tibiae with softer yellow pile; eyes black pilose.....*painteri* James, p. 480
51. Crossvein r-m only one-half the length of the basal part of Rs; posterior veins entirely obsolete; tarsal joints very slightly swollen, not nearly as broad as end of femora; pile of dorsum dark yellow-brown; femora and tibiae dark on apical portion .....*conus* Hardy, p. 461
Crossvein r-m over one-half, usually equal to base of Rs; tarsal joints slender.... 52
52. Pile of dorsum black .....*tristis* Williston, p. 488
Pile of dorsum chiefly yellow 53
53. Wings chiefly hyaline to dusky; tibiae and tarsi of front two pairs of legs darker than femora, which are light reddish yellow; posterior legs entirely reddish yellow, joints darker .....*alienus* McAtee, p. 454
Wings slightly yellow fumose, tibiae and tarsi, of at least posterior legs, concolorous with femora 54
54. Thorax and abdomen entirely black. Posterior veins darker than the membrane. 54a *xanthopus* Wiedemann, p. 491
Posterior margin of thorax, parts of pleurae, coxae and abdomen with dark reddish coloration. Posterior veins concolorous with membrane.....*rufalipes* Hardy, p. 482
54a. Pile pale, less abundant; wings yellowish fumose; pleurae of female often in part yellow to rufous .....*xanthopus xanthopus* Wiedemann, p. 491
Pile more abundant, gray to black; wings somewhat smoky; pleurae of female black (western) .....*xanthopus palliatus* McAtee, p. 492

KEY TO THE SPECIES OF FEMALE *Bibio*

1. Inner spurs of front tibiae short, not more than one-half the length of the outer... 2
Inner spurs conspicuously more than one-half the length of the outer..... 8
2. Crossvein r-m at least one-half the length of the basal section of the radial-sector, 16
Crossvein r-m short, not more than one-third the length of the basal section of the radial-sector 3
3. Legs entirely black, or dark brownish red, never rufous..... 4
Legs chiefly rufous, posterior basitarsi just one and one half-times as long as second tarsal subsegment 6
4. Posterior basitarsi scarcely over three times as long as wide; smaller species (wing 4-6 mm.) 5
Posterior basitarsi almost six times as long as wide; usually large species (wing 5.5-9.5 mm.) 7
5. Wings dusky to smoky hyaline ..... 5a *melanopilosus* Hardy, p. 473
Wings hyaline to yellowish; pile of dorsum yellow..*albipennis* var. *tenuipes* Coquillett
5a. Pile of thorax, coxae and femora chiefly black, humeral ridge tinged with yellow; legs somewhat rufous.....*melanopilosus melanopilosus* Hardy, p. 473
Pile of thorax, coxae and femora pale, humeral ridge black; legs entirely black; slightly larger species, length of wing 6-6.5 mm, *melanopilosus biseptus* Hardy, p. 474

6. Thorax and abdomen chiefly black pilose; inner spurs of front tibiae about one-half the length of the outer ..... *curtipes* James, p. 462
Thorax and abdomen with grayish yellow pile; inner spurs not more than one-fourth the length of the outer ..... *kansensis* James, p. 469
7. Humeri each with large conspicuous red-spot in addition to the yellow of humeral ridges; pleurae with rufous markings. Wings smoky..... *conjunctivus* Hardy, p. 460
Thorax entirely black, except for pale humeral ridges..... 7a *albipennis* Say, p. 451
7a. Wings hyaline 7b
Wings dusky ..... *albipennis beameri* n. sub. sp., p. 451
7b. Pile usually longer and more abundant, especially on males (western). *albipennis hirtus* Loew, p. 452
Pile shorter and less abundant (eastern)..... *albipennis albipennis* Say, p. 451
8. Femora lighter in color than tibiae and tarsi, dorsum of thorax black..... 9
Femora not thus contrasting, if tibiae are of darker color, the dorsum is rufous... 11
9. Tibiae and tarsi dark reddish brown; wings yellow fumose; all leg joints dark tipped ..... *velorum* McAtee, p. 490
Tibiae and tarsi black, only tibial spurs rufous. Wings blackish..... 10
10. Coxae and trochanters rufous, anterior pair lighter..... *mickeli* Hardy, p. 474
Coxae and trochanter entirely black..... *femoratus* Wiedemann, p. 463
11. Wings smoky, blackish costally..... *basalis* Loew, p. 456
Wings slightly yellowish hyaline to yellow-brown..... 12
12. Wings only slightly yellowish hyaline; inner tibial spur but slightly over one-half the length of outer 13
Wings yellow-brown; inner tibial spurs always conspicuously over one-half the length of outer 14
13. Smaller species, wing 4-5 mm. in length; leg joints somewhat shortened giving the legs a drawn up appearance; inner spurs of front tibiae but slightly over one-half the length of the outer ..... *carri* Curran, p. 458
Larger species, wing 7-8 mm.; leg joints not shortened, 13a *xanthopus* Wiedemann, p. 491
13a. Pleurae wholly dark..... *xanthopus palliatus* McAtee, p. 492
Pleurae in part yellow to rufous..... *xanthopus xanthopus* Wiedemann, p. 491
14. Smaller species, wing 4.5-6.5 mm..... 15
Larger species, wing 7.5-9.5 mm..... *nervosus* Loew, p. 477
15. Hind metatarsi six to seven times as long as wide, tibial spurs extend about one-third the length of metatarsi; thorax chiefly rufous, sometimes with only a slight tinge of red on the dorsum ..... *fraternus* Loew, p. 465
Hind metatarsi not more than three to four times as long as wide, spurs of hind tibiae extending almost half the length of metatarsi; thorax black, *abbreviatus* Loew, p. 450
16. At least the mesonotum chiefly rufous..... 17
Top of thorax chiefly or entirely black, never with more than anterior margins of humeral ridges pale 26
17. Dorsum of thorax or the pleurae with dark brown to black markings; thorax never entirely rufous 18
Entire thorax rufous 22
18. Legs dark brown to black; larger species..... 19
Legs rufous to yellowish 20
19. Length of head behind the eyes much shorter than length of the eyes (fig. 201b); face not tuberculate in middle; head and prothorax finely shagreened; scutellum shining black ..... *rufithorax* Wiedemann, p. 483
Length of head behind eyes longer than length of eyes (fig. 187a); face tuberculate in the middle; head and prothorax brightly polished and smooth; scutellum rufous. *carolinus* n. n., p. 457
20. Larger species, wing 8-9 mm. Wings dark yellow fumose....*fumipennis* Walker, p. 466
Smaller species, wing 5-7 mm. Wings chiefly hyaline or but lightly yellow fumose, 21
21. Dorsum of thorax entirely reddish yellow; posterior tibiae not noticeably clavate. *alexanderi* James, p. 453
Dorsum of thorax with black markings; posterior tibiae clavate...*painteri* James, p. 480
22. Abdomen as well as thorax and legs chiefly reddish or testaceous, with only minor dark markings 23
Abdomen black 25

23. Tibiae and tarsi brownish red, darker in color from yellowish red femora. *rufalipes* Hardy, p. 482
Tibiae and tarsi yellow to rufous, not darker than femora 24
24. Larger species, wing 7-8.5 mm., wings yellowish in both sexes ....*inaequalis* Loew, p. 468
Smaller species, wing 5-6 mm., wings of female smoky yellow fumose, of male hyaline ..... *townesi* Hardy, p. 487
25. Hind coxae blackish, wings dusky fumose ..... *alienus* McAtee, p. 454
Hind coxae rufous, wings yellowish fumose ..... *longipes* Loew, p. 472
26. Entire anterior margin of mesonotum pale; pleurae and abdomen in part reddish; legs including coxae and trochanters bright yellow ..... *lobatus* Hardy, p. 471
Only humeral ridges pale 27
27. Only femora rufous ..... *holti* McAtee, p. 467
More of legs yellow to rufous 28
28. Smaller species, wing 5-7 mm. (only *monstri* and *flukei* from 6-7 mm.) 29
Larger species, wing 7.5-9 mm 36
29. Wings dusky hyaline to smoky gray fumose 30
Wings hyaline to yellow fumose 31
30. Coxae and trochanters black, femora of male black ..... *nigrifemoratus* Hardy, p. 478
Coxae and trochanters rufous, femora of male refous ....*knowltoni paltidus* Hardy, p. 470
31. Coxae and trochanters rufous; pleurae usually with rufous markings. Posterior veins darker than the membrane 33
Coxae, trochanters and pleurae black or tinged with dark reddish brown 32
32. Posterior veins concolorous with the membrane, coxae and trochanters black 34
Posterior veins darker than the membrane, coxae and trochanters tinged with dark reddish brown (atypical specimens of this species will key out here) ..*carri* Curran, p. 458
33. Wings dark yellow fumose, legs rather slender, the joints more elongate; crossvein r-m slightly longer than basal part of the Rs; posterior basitarsi of male swollen. *slossonae* Cockerell, p. 486
Wings hyaline to slightly yellow fumose; legs more robust; crossvein r-m slightly shorter than basal part of Rs; posterior basitarsi of male not swollen. *knowltoni knowltoni* Hardy, p. 469
34. All femora brownish yellow, much darker in color than tibiae; posterior veins pale brown, darker than the membrane ..... *flukei* Hardy, p. 464
Femora yellow to rufous, not darker than tibiae; posterior veins concolorous with the membrane 35
35. Tibiae and tarsi broadly black tipped, last four tarsal subsegments chiefly black. Larger than succeeding species; wing 6-7 mm ..... *monstri* James, p. 475
Leg joints chiefly rufous, not extensively tipped, smaller species, wing 4.5-5.5 mm. *sericatus* Hardy, p. 484
36. Wings yellowish fumose 37
Wings dusky hyaline ..... *xanthopus palliatus* McAtee, p. 492
37. Crossvein r-m about one-half the length of the Rs; wing 7-7.5 mm.; posterior veins concolorous with membrane; legs chiefly yellow; posterior tarsal subsegments of male slightly swollen ..... *conus* Hardy, p. 461
Crossvein over one-half, usually equal to Rs; wing usually 8-9 mm 38
38. Posterior veins darker than membrane; posterior basitarsi of male not swollen. 38a *xanthopus* Wiedemann, p. 491
Posterior veins concolorous with the membrane; posterior basitarsi of male strongly swollen ..... *bryanti* Johnson, p. 456
38a. Pleurae of female wholly dark; male with the hair more copious and longer, usually darker sometimes wholly black (western), *xanthopus palliatus* McAtee, p. 492
Pleurae of female often in part yellow to rufous; male with less abundant and shorter hair, usually pale on thorax and abdomen. *xanthopus xanthopus* Wiedemann, p. 491

Bibio abbreviatus Loew

(Plate XXXVIII, figs. 182a-c)

Bibio abbreviatus Loew, 1864, Diptera Americae Septentrionalis indigena, Centuria, 5, No. 9, Compl. Work, p. 217.

Bibio abbreviatus Van der Wulp, 1881, Tijds. V. Ent. 24, 145. This is a homonym.

This species is related to *fraternus* Loew and is distinguished by the shorter and thicker tarsal subsegments of the male and the black dorsum of the female.

MALE.—Head and appendages, body (except pale humeral ridges) and coxae black, the pile of the head black, that of the body and legs pale; femora and succeeding leg joints, excepting front tibiae and the last two or three tarsal joints, yellow to rufous with dark tips, the anterior tibiae and last two to three tarsal subsegments dark brown to black. *Leg:* Spurs of anterior tibiae rufous, the inner spurs almost equal to the outer in length. Subsegments of hind tarsi comparatively short and thick, the metatarsi are about two and one-third times as long as the inner spurs of posterior tibiae (fig. 182b). *Wings:* Hyaline, anterior veins and stigma brown, posterior veins concolorous with membrane, radio-medial crossvein equal to the basal part of the posterior branch of radius. *Genitalia:* Ninth tergum deeply V-shaped on hind margin, the cleft extending over half the length of the segment (fig. 182c). Ninth sternum broad, cleft about one-third the length of the segment on hind margin. Claspers rather narrow (fig. 182a).

FEMALE.—Females differ in having pale yellow fumose wings; posterior veins yellowed, slightly darker than the membrane. Coxae and trochanters yellow to rufous; the pleurae sometimes having yellowish markings. The hair of the female is more sparse and the hind metatarsi are slightly more slender.

Length of wing, 4-6 mm.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

This species is rather wide spread. Specimens have been studied from the following states and Canadian provinces: Ohio, South Dakota, Michigan, Kansas, North Carolina, New York, Maryland, Missouri, Virginia, Iowa, Georgia, Quebec and Ontario. Also type locality.

Bibio articulatus Say, *B. pallipes* Say or *B. baltimoricus* Macquart might be the same as this species, or one or more of them the same as *fraternus* Loew. None of these descriptions refers to the character of the tarsal subsegments so they cannot be separated. Specimens determined as *B. pallipes* Say, in various collections studied have

proved to be the same as *abbreviatus*, but Say's type is apparently lost and the determinations must be questioned.

Bibio albipennis Say

(Plate XXXVIII, fig. 183a)

Bibio albipennis Say, 1823, Desc. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3; 78; 1859 Compl. Writings, vol. 2 p. 69.

MALE.—Entirely shining black, except for pale humeral ridges. *Legs:* Inner spurs of front tibiae short, approximately one third of the length of the outer. Spurs of hind tibiae thick and blunt, inner spur extending about one third the length of the metatarsus (fig. 183a). Posterior metatarsi not swollen and about twice the length of the second joint, metatarsi about six times as long as wide. Hind femora average 2.9 mm. in length, hind tibiae 2.6 mm. Legs sometimes verging into brownish black but more consistently shining black. Pile of eyes dark brown to black, long and copious, that of the face gray; body, coxae and femora with pale yellowish to gray hair; tibiae and tarsi with short dark hair. *Wings:* Whitish hyaline; stigma and anterior veins dark brown, posterior veins lighter brown, darker than the membrane; radio-medial crossvein about one fourth the length of the basal part of the posterior branch of radius.

FEMALE.—The female differs in usually having reddish brown markings on the pleurae (sometimes entire body tinged), and the pile much more sparse and shorter.

Length of wing, 7-9.5 mm.

Type locality: Pennsylvania.

Type probably lost.

The type form seems to range east of the Rocky Mountains; the species is the most common of the Nearctic Bibionidae.

Bibio albipennis beameri n. sub. sp.

(Plate XXXVIII, figs. 184a-b)

This has been considered the same as *afer* McAtee [44] (nec Loew). It fits the description as being related to *albipennis* but differs in having the wings dusky fumose. Examination of the type of *afer* proved that these are not related. That the specimen described as *afer* McAtee is actually related to *Bibio rufithorax* Wiedemann.

In working with this form the writer has often debated its possible rank. In Kansas and the middle west it appears to be a distinct species but as there is such a great amount of variation over large series of *albipennis* Say and it is not uncommon to find dusky winged

44. 1923, Proc. Ent. Soc. Wash. Vol. 25, No. 3, 63.

variants, it is perhaps better to include this character in the specific concept.

The subspecies differs from typical *albipennis* in having the wings darker fumose and being smaller in size; the posterior median margin of the ninth sternum in the male is also more pronounced. The specimens are more sparsely pilose than *albipennis*, markedly more so than the subspecies *hirtus* Loew; wings yellow-brown to smoky fumose instead of milky white as in the typical form. The type series, from Kansas, are all of smaller size than *albipennis;* variants have been examined from other localities which verge into this subspecies. The females have a tinge of dull red on the legs, pleurae and abdomen; the hind portions of the humeri are dull red and the wings more brownish fumose.

Male genitalia: Ninth sternum broader than long with a pronounced gibbosity in the middle on hind margin; harpagones rather slender and curved (fig. 184a). Ninth tergum deeply cleft, with a small membranous portion in the bottom of the cleft (fig. 184b).

Length of male: body and wings 6 mm.

Length of female: body and wings 6.7 mm.

Holotype male, allotype female and one hundred and thirty-eight paratypes, one hundred and five males, thirty-three females, Douglas County, Kansas, May 11, 1931 (R. H. Beamer). All are in the Snow Entomological Collection.

Bibio albipennis hirtus Loew.

Bibio hirtus Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 2, 1864, compl. work, p. 213.

Similar to *albipennis*, the only distinction being the more copius and longer hair, especially in the males. In some cases the hair is much darker. The legs of the males are usually never tinged with brownish red; the females are usually entirely shining black. The anterior veins of the wing in both sexes are usually black and the posterior veins gray.

There is no sharp distinction between these two subspecies and in various localities they may intergrade. Generally *hirtus* seems to be confined to the western portion of North America and *albipennis* to the eastern.

Type locality: California.

Type in Cambridge Museum of Comparative Zoölogy.

Bibio albipennis var. *tenuipes* Coquillett

(Plate XXXVIII, fig. 185a)

Bibio tenuipes Coquillett, 1902, Proc. U. S. Nat. Mus., V. 25, p. 95. New combination.

This is apparently just a variety of *albipennis*. The only essential difference is its smaller size. This varies a great deal and so many intergrading forms appear in any large series of *albipennis* that no specific boundary can be set up. The *tenuipes* variety does not appear to be restricted in geographical distribution so can hardly be subspecific.

MALE.—Chiefly shining black, except for yellow humeral ridges and rufous tibial spurs. Pile of the eyes black, that of the under side of the head gray; thorax, abdomen, trochanters and femora with pale yellow to gray pile, that of tibiae and tarsi chiefly black. Legs rather shortened and appearing somewhat drawn up. Inner spurs of front tibiae very short, about one fourth the length of the outer (fig. 185a); hind femora clavate, tibiae only slightly so, outer edges almost straight; posterior basitarsi not enlarged and comparatively short, about one and one-half as long as the next segment. Wings hyaline, tinged with yellow in the costal cell and with gray in the marginal and basal cells; anterior veins and stigma dark brown, posteriors lighter.

FEMALE.—The female differs in having all pile short, pale yellow and legs tinged rather extensively with rufous; front femora strongly swollen and the wings more yellow fumose.

Type locality: Arizona.

Type in the United States National Museum.

The writer has identified the variety from Texas, Utah, Washington and Wisconsin. McAtee reports it from Colorado and New Mexico.

Bibio alexanderi James

Bibio alexanderi James, 1936, Some New Western Bibionidae, Amer. Mus. Nov. No. 382, p. 1-2.

This species is related to *fraternus* Loew and to *painteri* James, the shorter inner spurs of front tibiae will distinguish it from the first species and the more slender posterior tibiae and the short, sparse yellow pile of the eyes will separate it from the latter.

MALE.—Head and appendages, body (excepting the pale humeral ridges), coxae and trochanters black. Pile of eyes rather short and chiefly yellowish, that of remainder of head pale yellow to gray, with some black pile on the lower part of the occiput; pile of body and

legs chiefly yellow, quite dense and long. *Legs:* Femora, tibiae and first one or two joints of tarsi yellow-rufous, very slightly darkened at the end of the joints; remainder of tarsi dark brown to black. Inner spurs of the front tibiae not quite one-half the length of the outer; posterior basitarsi not enlarged, about twice the length of the second segment. *Wings:* Slightly dusky fumose, clouding somewhat deeper along the costal margin; veins and stigma brown, posterior veins but little lighter than the anteriors; radio-medial crossvein equal to the basal part of posterior branch of radius, basal section of M_2 faint.

FEMALE.—The females differ sharply from the males in that the entire dorsum of the thorax (excepting dark brown to black pronotum), coxae and trochanters are yellow to rufous and the pleurae are quite extensively rufous with black markings. Pile more sparse.

Length of wing, 6 mm.

Type locality: Boulder Creek Bottoms, near Valmont, Colorado.

Type in American Museum of Natural History.

The author has identified specimens from Stillwater, Oklahoma, March, 1936 (A. E. Prichard).

Bibio alienus McAtee

Bibio alienus McAtee, 1923, Descriptions of Bibio from the Carolinas. Proc. Ent. Soc. Wash., Vol. 25, No. 3, 62-63.

The writer having not definitely identified this species prefers to give McAtee's original description.

"*Male.*—Head and body black, the humeral ridges yellowish; short, erect hair upon eyes black; longer, flexuous hair of occiput dark, of thorax and abdomen whitish. The legs have the coxae, trochanters, tibiae and tarsi of first two pairs brownish to blackish, all femora reddish-yellow, hind legs of this color throughout, the joints more or less blackish distally. Wings nearly hyaline, a little fumose along costa, the stigma moderate in size, dark brown. Length of wing: 5-5.5 mm.

"*Female.*—Head black, abdomen brownish-black, thorax and most of legs reddish-yellow, front tibiae, hind coxae and tips of other leg joints blackish; hair of head, thorax and legs rather bristly, that of abdomen somewhat softer, pale reddish. Wings dusky fumose, darker costally, the stigma and veins near costa blackish. Length of wing: 7 mm."

McAtee states that the male of this species is close to *nervosus* Loew but that the pile of the occiput, eyes and thorax is longer and

more copious, and the wings are darker. From his description they would seem to differ by the posterior tibiae and tarsi contrasting in color from those of the anterior legs.

The female seems to be near *longipes* Loew but differs in that the hind coxae are blackish, and the wings more dusky.

Type locality: Raleigh, North Carolina.

Type in United States National Museum.

Bibio atripilosus James

(Plate XXXVIII, figs. 186a-b)

Bibio atripilosus James, 1936, Amer. Mus. Nov. No. 832, 2.

Near *vestitus* Walker but differing in that the pile of the thorax, abdomen and legs is dense, pale yellow and the femora are mostly black, slightly reddish apically.

MALE.—Head and appendages, body (humeral ridges yellowish), and trochanters black. Pile of eyes, upper part of face and occiput copius black; that of the under part of the face long, dense, yellow-gray; that of the body, coxae and femora whitish to yellow-gray; first two to three segments of the abdomen with dense patches of gray pile on lateral margins. *Legs:* Femora chiefly black, rufous apically; front femora each with a rufous stripe running longitudinally, bordered by black above and below. Tibiae rufous with brownish markings medially and apically. Inner spurs of front tibiae short, about one-third the length of the outer. Basitarsi about twice as long as the succeeding joint, first two basal joints of tarsi yellowish-black at apices, next three subsegments verging into black. *Wings:* Hyaline, anterior veins and stigma dark brown, posterior veins light brownish yellow; crossvein r-m equal in length to the basal part of Rs. *Genitalia:* Cleft of ninth sternum very shallow and broad, distinctly shaped, the inner margins being indented giving a steplike appearance; the sternum is produced into an acute point on each inner margin at base of harpagones. Harpagones broad medially, each with a long apical point and a short tooth developed on the inner edge (fig. 186a). Ninth tergum gently concave on posterior margin, segment about twice as wide as long on median line. Cerci strongly developed and quite heavily sclerotized (fig. 186b). Pile of genitalia long and yellow.

Length of wing, 7 mm.

Female unknown.

Type locality: Boulder, Colorado.

Type in the American Museum.

This author has identified specimens from Petersboro, Utah, 4-27-35 (F. H. Gunnell); Price, Utah, 7-14-35 (F. C. Harmston) and Paradise, Utah, 5-4-37 (G. F. Knowlton).

Bibio basalis Loew

Bibio basalis Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 11, Comp. work, p. 217.

FEMALE.—Head and body black, coxae rufous, the posterior ones somewhat darker than anteriors; femora, tibiae (except front pair which are shining black, with rufous spurs) reddish, with black tips; basitarsi yellow with black tips, other tarsal joints chiefly black. Inner spurs of front tibiae long, but slightly shorter than outer. Pile of head, body, coxae and femora yellow to reddish yellow; that of tibiae and tarsi brown to black. Wings dusky fumose, darker costally; anterior veins and stigma black, posteriors brown; r-m crossvein equal in length to basal part of Rs.

Length: wing, 5.5-9 mm.

Male unknown.

Type locality: New Hampshire.

Females fitting the description of this species have been examined from British Columbia, Massachusetts, New Hampshire and Utah. McAtee reports a female answering the description (except for size) from Manning, South Carolina, with a wing length of 5.5 mm. This is a rather wide range, and since the males of the species are unknown and the original description is so meager, their identification is by no means certain.

Type in Cambridge Museum of Comparative Zoölogy.

Bibio bryanti Johnson

Bibio bryanti Johnson, 1929, Diptera of Labrador, Psyche, XXXVI, 133.
Bibio lacteipennis Curran (nec Zetterstedt), 1924, Can. Ent. LVI, 250.
Bibio currani Hardy, 1937, Proc. Utah Acad. Sci. XIV, 200-201.

B. currani was a change of name for *lacteipennis* Curran (nec Zetterstedt). New synonomy based upon a study of the type.

Following is the original description of the male:

"Head, antennae and palpi black, pile of eyes long and brown. Thorax black, shining with long black pile. Abdomen black with whitish pile. Legs reddish, with yellowish hairs, coxae and knees black, inner spur of front tibiae about one-half the length of outer one, the posterior tibiae and metatarsi enlarged, the latter about as long as the second and third joints combined. Wings hyaline, the costa, stigma and first and second veins brown. Halteres dark brown."

FEMALE.—With shorter more sparse pile, a few yellowish hairs intermixed with darker pile. Posterior metatarsi not so enlarged as in the male although the hind femora are equally as strong.

Length of wing 8-10 mm.

Type locality: Nain, Labrador.

Type in Cambridge Museum of Comparative Zoölogy.

Also has been recorded from Rama, Labrador and Mt. Revelstoke, B. C.

Bibio bryanti var. *nigrita* Curran

Bibio lacteipennis var. *nigrita* Curran, 1924, Can. Ent. LVI, 250. New combination.

This differs from the typical *bryanti* in having the femora shining black, the posterior pair are somewhat reddish toward bases.

Type locality: Mt. Revelstoke, B. C.

Type in Canadian National Museum.

Bibio carolinus n. n.

(Plate XXXVIII, figs. 187a-d)

Bibio afer McAtee (nec Loew), 1923, Proc. Ent. Soc. Wash., vol. 25, No. 3. Change of name. *B. afer* preoccupied by Loew, 1854, Neue Beitrag Zur Kent. der Dipt. II.

This species is related to *rufithorax* Wiedemann. Refer to description notes on that species for distinguishing characteristics.

MALE.—Shining black species, except for yellow humeral ridges and reddish tibial spurs. McAtee, in the original description, states that there is a yellowish stripe on the inner side of each hind tibiae, but this appears to be exceptional as most specimens have the legs entirely shining black. Pile of the head, excepting some gray pile on the occiput, and of tibiae and tarsi brownish to black; that of thorax, coxae and abdomen chiefly grayish yellow; pile of femora mixed black and yellow. *Legs:* Inner spurs of front tibiae short, about one-third the length of the outer spurs. The legs have the appearance of being somewhat shortened; posterior tarsal subsegments (fig. 187d). *Wings:* Dusky fumose, all veins and stigma blackish, radio-medial crossvein short, not over one-fourth the length of the basal part of the posterior branch of radius. *Genitalia:* Cleft of ninth sternum broad and shallow. Harpagones slender and rather elongate, curved inward (fig. 187b). Ninth tergum deeply V-shaped on hind margin, cleft three-fourths the length of the segment (fig. 187c).

Length of wing: 6.3-6.5 mm.

FEMALE.—Females differ from males in being of larger size, the pile is much more sparse and that of the abdomen is chiefly yellow;

the pleurae and humeri have dull rufous markings. The length of the head behind the compound eyes is longer than the eye length and the middle of the face behind the antennae with small tubercles (fig. 187a). Head, propleurae, mesopleurae and sternopleurae chiefly bare. Scutellum bright reddish.

Length of wing: 8-9.3 mm.

This is the first report that has been made of the female. Only males were present in the type series.

Type locality: Raleigh, North Carolina.

Type in the United States National Museum.

The writer has studied the type and additional specimens from the type locality May 6-8, 1925 (C. S. Brimley); also specimens from St. Augustine, Florida, March 24, 1939 (W. Benedict).

Bibio carri Curran

(Plate XXXVIII, figs. 188a-b)

Bibio carri Curran, 1927, Descriptions of Nearctic Diptera. Can. Ent. vol. LIX, No. 4, p. 80.

The male of this species has never heretofore been recorded or described. The writer has examined numerous males taken in copulation at the type locality and at Lethbridge.

MALE.—Head and appendages, body (humeral ridges slightly yellowed posteriorly), coxae and trochanters shining black; eyes with yellow-brown pile; pile of body and legs chiefly yellow and rather sparse, some darker hairs on the tibiae. *Legs:* Robust, the joints seeming somewhat shortened giving them a drawn up appearance, average length of posterior femora 1.6 mm., posterior tibiae 1.5 mm.; femora and tibiae yellow to rufous, dark brown to black apically. Inner spurs of front tibiae a little over half the length of the outer; posterior metatarsi not at all swollen but the subsegments of tarsi are rather short and thick, metatarsi lighter in color than the other subsegments; posterior metatarsi not quite three times as long as wide, about twice as long as inner spurs of hind tibiae and next subsegments (fig. 188a); spurs of hind tibiae short, thick and blunt at apices. Posterior femora clavate, tibiae not noticeably so. *Wings:* Chiefly hyaline, with a slight tinge of yellow fumosity; radio-medial crossvein equal to the length of the basal part of the posterior branch of radius. Anterior veins and stigma yellow-brown, posterior veins lighter in color. *Hypopygium:* Ninth tergum with a narrow median cleft on hind margin, extending not quite half the length of segment (fig. 188b). Harpagones slender, acute at apices.

Length of wing, 4-4.2 mm.

FEMALE.—The female of this species is considerably larger than the male, the wing measuring 5-6 mm. The coxae, trochanters, abdomen and sometimes the thorax are tinged with dark reddish brown. Pile more sparse and shorter; otherwise like the male.

Type locality: Medicine Hat, Alberta.

Type in Canadian National Museum.

The author has examined specimens from this locality and from Lethbridge. Alberta, May 6, 1923 (L. H. Seamens).

Bibio cognatus Hardy

Bibio cognatus Hardy, 1937, New Bibionidae from Nearctic America, Proc. Utah Acad. Sci. XIV, 199-200.

This species is related to *nigrifemoratus* Hardy but is distinguished by its wholly black pile, yellow fumose wings and six segmented antennae. The palpi of the type appeared to be just three segmented but a small first segment may have been overlooked.

Following is the original description:

"*Male*.—Head black, body chiefly black, posterior border of humeral ridge yellow, pleura and ninth sternite tinged with dark reddish-brown. Coxae, trochanters, femora and proximal half of anterior tibiae reddish-brown, tibiae of the hind two pairs of legs, and all tarsi yellow-red tipped with brown apically; hind femora clavate, tibiae hardly so; posterior metatarsi not enlarged, about one and one-half to twice the length of the next segment; apical half and spurs of the anterior tibiae yellow, inner spurs above one-half the length of the outer. Pile of the head and body sparse and black, that of the posterior part of the abdomen (genital segments), and legs reddish-brown; radio-medial crossvein equal in length to basal part of the radial-sector; fork of the fourth longitudinal vein arising just beyond M-cu crossvein (base of M_2). Length of wing, 4 mm."

Female unknown.

Type locality: Ellery Lake, Tioga Pass, California.

Type in United States National Museum.

Bibio columbiaensis Hardy

Bibio columbiaensis Hardy, 1938, Can. Ent. LXX, 207-208.

This species is related to *fumipennis* Walker. It is distinguished by the pale femora and darker tibiae and tarsi, longer inner spurs on front tibiae and V-shaped cleft on hind margin of ninth tergum.

Following is the original description:

"*Male*.—Head, thorax (except yellow anterior margin of humeral ridges), coxae, trochanters and abdomen black. Head with dense,

long, black hair on the face and copious black pile on the eyes. Ocellar tubercle strongly developed, higher than that of *fumipennis*. Pile on dorsum of thorax yellow gray with some darker hairs intermixed, some hairs darker at bases. Pile of pleurae yellow, that of abdomen dense, yellow gray. All tibiae darker than femora, all femora rufous with black tips. Anterior and middle tibiae rufescent with a dark reddish-brown to black stripe running its entire length on the dorsal edge; entire apical one-third to one-half of tibiae sometimes reddish-brown to black. Posterior basitarsi enlarged but cylindrical and not globular, other tarsal segments swollen. Front and mid tarsi chiefly black, somewhat yellowed basally, yellow brown apically, other tarsal segments black. Pile of coxae, trochanters and femora yellow, that of tibiae and tarsi yellow red. Wings yellow fumose, somewhat darker costally; r-m crossvein slightly shorter than the basal part of the Rs. Humeral crossvein distinct.

"*Genitalia:* Genital cleft extending but a little over one third the length of the segment. Styli narrow and with distinct tufts of dark hair basodorsally. Superior plate (ninth tergum) deeply angulate emarginate, the cleft extending slightly more than half its length; apices obtuse, with edges gently rounded. The ninth tergum of *Bibio fumipennis* cleft over three-fourths its length, the cleft more broad basally and not angulate."

Length of wing: 7-7.2 mm.

Female unknown.

Type locality: Jesmond, B. C.

Type in Canadian National Museum.

Bibio conjunctivus Hardy

Bibio conjunctivus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 200.

This species is related to *albipennis* Say but the sclerites of the abdomen are small and reveal the light gray to dusky conjunctiva; the humeral ridges of both sexes are bright yellow and the female has a conspicuous yellow-red spot on each humeri. Following is the original description:

"*Male.*—Eyes and labellum light brown, the former with copious brown pile, the rest of the head and dorsum of the thorax, excepting the bright humeral ridges and pale stalks of halteres, shining black. The pleurae, sclerites of the abdomen and legs rufiscent-black; all but femora, tibiae and tarsi of the legs and the genitalia, with copious long yellow gray pile, and with dense patch of hair on the mesopleura; pile of the genitalia dark reddish to black, that of the

femore yellow to yellowish-brown, that of the tibiae and tarsi dark brown to black. Posterior femora and tibiae clavate, posterior metatarsi not swollen and slightly longer than succeeding two segments. Inner spur of front tibiae almost one-half the length of the outer. Wings milky hyaline, costal cell with a milky clouding; veins and stigma brown, radio-medial crossvein about one-fourth the length of the basal part of the radial sector.

"*Female.*—The female differs from the male in having a bright yellow-red spot on the sides of the humeri; pleurae with rufous markings; legs and sclerites of the abdomen tinged with rufous; posterior tibiae not clavate and wings fumose, milky basally.

"Length of wing, 7-8 mm."

Type locality: Plummer I., Maryland.

Bibio conus Hardy

Bibio conus Hardy, 1938, Can. Ent. LXX, 208-209.

Following is the original description:

"The species resembles somewhat *B. xanthopus* Widemann but differs distinctly in having the r-m crossvein one-half the length of the basal part of the radial sector; posterior veins concolorous with the membrane, the posterior tarsal segments slightly swollen but not approaching in size the end of the femora and tibiae.

"*Male.*—Head, thorax (except yellow humeral ridges), abdomen, coxae and trochanters black. Antennae with eight segments, pile of eyes, occiput, palpi and antennae black, that of face dark brown. Thorax rather sparsely pilose, pile of dorsum yellow-brown, that of pleurae, venter, abdomen (somewhat darker on genitalia), coxae, trochanter and femora yellow-gray, with a few yellow-brown hairs intermixed on femora. Pile of tibia and tarsi yellow to yellow-brown intermixed. Front and mid femora brownish black with a yellow tinge, lighter in the middle and darker on dorsal and ventral edges. Hind femora and all tibiae yellow basally with brown to black tips (tibial spurs rufous), hind femora darkened on apical half. The first two tarsal segments chiefly yellow, the last three chiefly black. Hind femora and tibiae clavate, inner spurs of front tibiae fumose, anterior veins and stigmata dark brown, posteriors concolorous with the membrane. Humeral crossvein pale and slightly interrupted just before the costa. Halteres brownish.

"*Female.*—The female differs in having the wings yellow fumose, pile of dorsum more yellowed, pleurae, coxae, trochanters and labellum with a yellow tinge; legs chiefly yellow to rufous, hind tibiae

straight or nearly so, tarsal segments slender, and cerci of genitalia yellowish."

Length of wing, 7-8 mm.

Type locality: Churchhill, Manitoba.

Type in University of Minnesota Collection.

Bibio criorhinus Bellardi

Bibio criorhinus Bellardi, 1859, Dipterologia Messicana, I, 17.

McAtee reports identifying a male of this species from the Graham Mountains, Arizona, June 1914 (E. G. Holt) and gives the following short description.

"Black except the subequal spurs of front tibiae, and the hind tibiae and tarsi which are rufescent, and narrow bases of front tarsal joints which are yellowish; head, body and coxae clothed with long dark hairs; those of the rather elongate legs shorter. Length of wing, 7 mm."

Type locality: Mexico.

Type in "Collesione del Musco Zoölogico di Parigi".

The writer has a Utah species which runs out as *criorhinus* but it is very probably not that species. A Mexican species has also been examined, the male of which fits the *criorhinus* description. The female, however, differs strikingly from any forms which have been observed from the temperate zone. Further acquaintance with materials from Central and South America will no doubt clarify this matter.

Bibio curtipes James

Bibio curtipes James, 1936, Amer. Mus. Novit. No. 832, 5-6.

This species approaches *melanopilosus* Hardy but differs in having the legs more extensively yellow, the posterior basitatsi very short, wings less dusky and some pale hair on the thorax and abdomen.

The following is the original description:

"*Female.*—Head, with appendages, thorax and abdomen, wholly black; pile of head black; that of thorax black, intermixed with white; that of abdomen black on the disc, both dorsally and ventrally, a little whitish laterally. Legs yellow, short, the segments thick; the coxae slightly darkened, the apical two or three tarsal segments moderately so; pile very largely black. Halteres black. Inner claw of anterior tibiae about one-half the length of the outer one. Posterior femora clavate, the tibiae not so. Posterior basitarsi barely longer than the second tarsal segment. Wings slightly infumated; the anterior veins blackish, the posterior ones yellowish,

but distinctly darker than the membrane; stigma distinct, black. Crossvein r-m one-fourth the length of the basal part of vein Rs. Length, 6-7 mm.

"*Male*.—Eyes with moderately long and moderately dense black pile. Coxae, trochanters, and femora black; the tibiae and tarsi brownish yellow, the latter more darkened apically. The pile of the body may be entirely black, or there may be a little pale pile on the dorsum of the thorax and on the abdomen laterally. Otherwise as in the female."

Type locality: Boulder, Colorado. Also recorded from Walsenburg, Colo. and Bothwell, Utah.

Type in American Museum.

Bibio femoratus Wiedemann

(Plate XXXIX, fig. 189a)

Bibio femorata Wiedemann, 1828, Ausz. Zweifl. Insekton, 1, 79.
Bibio fuscipennis Macquart, 1838, Dipt. Nouv. ou peu connus, vol. 1.
Bibio senilis Wulp, 1869, Nogiets over Noord-Amer. Dipt., Tijdsc. voor Ento. 12, 81-82.

This species is easily recognized by the bright red, contrasting femora and the long inner spurs of front tibiae (fig. 189a).

MALE.—Entirely shining black species, except for the conspicuously rufous femora and the ruficent tibial spurs and humeral ridges; bases of tarsal joints sometimes rufous, and in occasional specimens the entire tibiae are tinged; femora narrowly black tipped. Hair of the head dark, some yellow-gray pile on the face; that of the body, coxae and femora long, pale yellow; tibiae and tarsi with short brown to black hairs. *Wings:* Hyaline to pale yellow fumose, more fumose costally; anterior veins and stigma dark brown, posteriors light brown; r-m crossvein about equal to basal part of vein Rs.

FEMALE—The female differs in having the pile more sparse, shorter and entirely yellow, except on the tibiae and tarsi; the wings yellow-brown fumose to smoky black.

Length of wing, 7-9 mm.

Type locality given as North America.

Type in Vienna Museum.

This species is very wide spread. Specimens have been examined from the following states and provinces: British Columbia, Colorado, Connecticut, Illinois, Iowa, Kansas, Maryland, Mississippi, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Oklahoma, Ohio, Pennsylvania, Quebec, Saskatchewan, Utah, Virgina and Washington. The females from Iowa have very black wings.

Bibio fluginatus Hardy

Bibio fluginata Hardy, 1937, Proc. Utah Acad. Sci. XIV, 201.

Following is the original description:

"*Male.*—Head, body, (with the exceptions of pale humeral ridges) and coxae black; tergites of the abdomen somewhat yellowed laterally; femora and succeeding leg joints, except the last three tarsal segments, yellow to rufous with slight dark tips; anterior tibiae somewhat darkened at the base of the spurs. Inner spurs of anterior tibiae shortened, one-third to one-fourth the length of the outer; posterior femora and tibiae rather strongly clavate, the latter slightly thicker; posterior basitarsi noticeably enlarged but not strongly swollen or globular. Pile rather short and more sparse than in most species, that of head dark, that of body, coxae and femora yellow, of tibiae and tarsi yellow to brown intermixed. Knobs of halteres brown, stems ochraceous. Wings yellow fumose, anterior veins and stigma dark brown, posterior veins pale brownish yellow; cross-vein r-m equal in length to basal part of Rs.

"Length of wing, 4 mm.

"Female unknown."

Type locality: Salmon Arm, British Columbia.

Type in the United States National Museum.

Bibio flukei Hardy

(Plate XXXIX, fig. 190a)

Bibio flukei Hardy, 1937, Proc. Utah Acad. Sci. XIV, 202.

This species is readily recognized by the bicolored legs and short globose posterior metatarsi of the male. Following is the original description of the male with additional leg characters:

"*Male.*—Head and appendages, body (except yellow humeral ridges), coxae, trochanters, anterior femora and basal three to four tarsal segments, black; mid and posterior femora yellow on their basal half (basal constriction), dark brown to black on the apical half, front femora dark reddish brown; all tibiae and basitarsi chiefly yellow, all except anterior tibiae, with dark tips. Inner spurs of front tibiae very short, not over one-fourth the length of the outer, posterior femora and tibiae clavate, the latter strongly so, swollen apically, much larger than the femora; posterior basitarsi greatly enlarged and more or less globular, not greatly lengthened and equally as thick as the femora. Pile of the head brown to black, that of the body and legs sparse yellow, some dark pile on the tarsi. Wings yellow fumose, anterior veins and stigma brown,

posterior veins yellow; r-m crossvein equal to the basal part of the Rs; fourth vein arising before m-cu crossvein.

"Length of wing, 6-6.5 mm."

The outer spurs of front tibiae extend about half the length of the metatarsi; the outer spurs of hind tibiae are slender and acutely pointed while the inner are shorter and obtuse. Hind metatarsi only about two and one-half times as long as wide (fig. 190a). Hind femora average 2.5-2.7 mm., hind tibiae 2-2.2 mm.

FEMALE.—Legs more yellowish, all femora brownish, yellow instead of so extensively black, tibiae and first two subsegments of tarsi yellow. Hind tibiae not so clavate, tarsal subsegments slender, metatarsi five times as long as wide.

Length of wing, 7 mm.

Type locality: Cameron Pass, Colorado.

Type in the American Museum.

The writer has examined a good series of specimens from the type locality: Aug. 19-22, 1940 (R. H. Beamer, C. W. Sabrosky) and specimens from Monarch Pass, Colorado, alt. 11,362 ft., Sept. 5, 1938 (D. E. Hardy, A. T. Hardy). It has also been recorded from Pingree Park, and Tennessee Pass, Colorado.

Bibio fraternus Loew

(Plate XXXIX, figs. 191a-b)

Bibio fraternus Loew, 1864, Dipt. Amer., Sept. indig., Cent. 5, No. 8, Compl. Work, p. 216.

Specimens in the Snow Entomological collection determined *articulatus* Say by C. F. Adams belong to *fraternus* but as Say's description is inadequate and his type is apparently lost the position of *articulatus* must be questioned.

This species is related to *abbreviatus* Loew but is distinguished by the more elongate, slender metatarsi and the rufous colored dorsum of the females.

MALE.—Head and appendages, body, coxae and trochanters black. *Legs:* Chiefly yellow to rufous, joints dark tipped; anterior tibiae sometimes dark brown to black. Inner spurs of front tibiae almost as long as the outer. Subsegments of posterior tarsi slender and elongated, metatarsi about three times the length of the inner spurs on hind tibiae and about seven times as long as wide, about equal in length to the next three subsegments (fig. 191a). Posterior femora average 2.6 mm. in length; posterior tibiae, 2.4 mm. Pile of head dark gray to black, body and legs, excepting tibiae and tarsi, with long yellow pile; tibiae and tarsi with short black hairs. *Wings:*

Chiefly hyaline, sometimes slightly yellow fumose, anterior veins and stigma brown, posterior veins very pale, almost concolorous with the membrane. Crossvein r-m equal to basal part of the posterior branch of radius. Ninth tergum with a V-shaped cleft on hind margin, extending about half the length of the segment (fig. 191b).

Length of wing 5-6 mm.

FEMALE.—Differs in having all pile, except that of tibiae and tarsi, short, sparse and pale. The coxae, trochanters and dorsum of the thorax are rufous, pleurae usually with rufous markings. Wings yellow to yellow-brown fumose, anterior veins darker than the membrane.

Length of wing, 5.8-6.6 mm.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

This species is very widespread and has been seen from the following states and Canadian provinces: Colorado, Connecticut, Illinois, Iowa, Kansas, Kentucky, Maryland, Manitoba, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Ontario, Tennessee, Utah, Virginia, and Wisconsin. The writer has studied the type.

Bibio fumipennis Walker

Bibio fumipennis Walker, 1848, List of the specimens of Dipterous Insects in the collection of the British Museum, 1, 122.

MALE.—Head and body (excepting yellow posterior edge of humeral ridges), coxae and trochanters black. Head with copious dark pile, that of the body and legs yellow (tibiae and tarsi reddish yellow). *Legs:* Femora and succeeding leg joints yellow to rufous, only the femora dark tipped. Inner spurs of front tibiae but slightly over one-third as long as outer; posterior femora and tibiae clavate; posterior metatarsi enlarged and swollen but not globular, about as long as next two subsegments. *Wings:* Slightly yellowish fumose, anterior veins and stigma brown, posterior veins concolorous with membrane; crossvein r-m almost equal to the basal part of the Rs.

FEMALE.—Related to *rufithorax* Wied. but differing in that the legs are yellow to rufous and the wings dark, yellow-brown fumose. Head and appendages black, dorsum of thorax and legs, rufous; pleurae with dark brown to black markings; halteres yellow-brown; abdomen dark brownish red, cerci yellow. Pile short, chiefly red-

dish yellow. Wings yellow fumose, darker costally, anterior veins and stigma yellow-brown, posterior veins concolorous with the membrane.

Length of wing, 7.5-9 mm.

This is the first time the female of this species has been described or reported, as far as is known by this writer.

Type locality: St. Martin Falls, Albany River, Hudson Bay.

Type in British Museum.

Specimens have been examined from Alaska, Alberta, British Columbia, New York, Ontario and Utah. It has also been reported from New Hampshire.

Bibio holtii McAtee

(Plate XXXIX, fig. 192a)

Bibio holtii McAtee, 1921, Proc. U. S. Nat. Mus. vol. 60, Art. 11, p. 11.

Related to *femoratus* Wied. but easily separated by the short inner spurs of front tibiae.

MALE.—Head, body, coxae and trochanters black; femora bright yellow to rufous, tibiae and tarsi, except for rufous anterior tibial spurs, brown to black. Pile of the head, tibiae and tarsi dark, otherwise yellow. *Legs:* Inner spurs of front tibiae short, about one-third to one-fourth the length of the outer (fig. 192a); posterior femora and tibiae clavate, hind metatarsi slightly enlarged. *Wings:* dusky or slightly yellow fumose; anterior veins and stigma brown, posterior veins concolorous with the membrane; r-m crossvein almost equal to the basal part of Rs.

Length of wing, 6-7 mm.

FEMALE.—The female differs in having dark yellow fumose wings, and shorter pile. This is the first report of the female.

Length of wing 8 mm.

Members of this species are the strongest fliers of the Bibionidae that have been observed by the writer, they are usually taken in mountain regions hovering high above the ground, ordinarily well out of reach of the insect net.

Type locality: Graham Mts., Arizona.

Type No. 24700 in United States National Museum.

Specimens have been examined from many localities in the following western states and Canadian province: Arizona, British Columbia, Colorado, Oregon, Utah, Washington and Wyoming.

Bibio inaequalis Loew

(Plate XXXIX, figs. 193a-d)

Bibio inaequalis Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 3, Compl. Work, 213-214.

Bibio fumidus Coquillett, 1899, Report on Diptera of the Commander Islands, 343.

Bibio simplicis Curran, 1923, Can. Ent., Vol. 55, p. 245. New synonomy based upon comparison of type males.

The typical specimens of *inaequalis* from the Far North are larger and not so brightly rufous as our Eastern United States specimens, and the temperate region form may prove to be a distinct subspecies.

MALE.—Head, body (except pale humeral ridges), coxae and trochanters black; femora and succeeding leg joints reddish-brown to rufous with dark tips; anterior tibiae and last three tarsal segments usually darker. *Legs:* Inner spurs of anterior tibiae not one-half the length of the outer (fig. 193b); femora swollen, the posterior ones and tibiae clavate; posterior metatarsi enlarged and slightly longer than the next two subsegments. Pile of head brown to black, that of body and coxae pale yellow, of the succeeding leg joints yellowish-red, with some darker hairs on the tibiae and tarsi. *Wings:* Pale yellowish fumose, anterior veins and stigma brown, posterior veins, except yellowed basal portions, concolorous with the membrane; r-m crossvein about equal in length to basal part of R_5. *Genitalia:* Ninth sternum cleft almost half its length, sides of cleft almost straight, bottom undulated. Harpagones long and slender, strongly curved (fig. 193d). Ninth tergum almost as long as wide, deeply cleft on hind margin; cleft extending about three-fourths the length of the sclerite (fig. 193c).

FEMALE.—The female differs in having shorter, all yellow pile and only the head black; notum and pleurae rufous, sometimes with discolored vittae on the dorsum; abdomen yellow-brown; femora and suceeding leg joints more yellow.

Length of wing, 6-7.5 mm.

Type locality: Sitka, Alaska.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been reported from Unalaska, Iditarod and Saldovia, Alaska, Copper Island and Karagi Island, Kamchatka; Nordegg, Alta.; and Banff, Alta.

The writer has examined the type series and has also identified specimens from Labrador, Newfoundland, Wyoming, New York and Massachusetts.

Bibio kansensis James

(Plate XXXIX, fig. 194a)

Bibio kansensis James, 1936, Amer. Mus. Novit. No. 832; 6.

This species is closely related to *curtipes* James but differs in having more pale hair on the thorax and abdomen and legs more rufous. The following is the original deschiption with additional notes on the leg characters.

"*Female.*—Black, the pile of the body mostly grayish; legs short, thick, a somewhat obscure yellow in color, the coxae and trochanters darkened, the pile of the legs grayish to black, that of the tibiae stubby; the inner spur of the anterior tibiae not more than one fourth the length of the outer one; posterior basitarsi flattened, barely longer than the second tarsal segment. Wings dusky hyaline; veins brown, heavier near the costa; stigma brown; cross-vein r-m one-third to one-fourth the length of the basal part of the radius sector. Length, 5-6 mm. (the type specimens studied by the writer measured 4-4.3 mm., wing and body).

"*Male.*—Similar to the female; the pile of the body tends to be longer and darker, and the legs are slightly darkened."

The outer spur of front tibiae extends about two-thirds the length of the metatarsus; spurs of middle tibiae slender, acutely pointed, extending half the length of the metatarsus; spurs of hind tibiae thick and broadly rounding at apices. Hind metatarsus not much over twice as long as wide and about one and one-half times as long as the next subsegment (fig. 194a).

Type locality: Kirwin, Kansas.

Type in American Museum of Natural History.

Up to date this species has only been reported from Kansas. The writer has studied paratopotypes.

Bibio knowltoni Hardy

Bibio knowltoni Hardy, 1937, Proc. Utah Acad. Sci. XIV, 202-203.

This species is related to *abbreviatus* Loew. It is distinguished by the short inner spurs of front tibiae and the dark posterior veins of the wing. Following is the original description:

"*Male.*—Head and appendages, body (excepting pale humeral ridges), coxae and trochanters black; posterior femora and tibiae yellow to rufous, with dark tips, the former clavate; middle femora and tibiae slightly darker in color and front femora and tibiae dark rufous with black markings; basal half of anterior tibiae entirely black, spurs rufous. Inner spurs one-third to one-fourth the length

of the outer; metatarsi of all legs yellow basally and dark brown to black apically; other segments brown to black; posterior metatarsi not swollen and rather short, about one and one-half times the length of the next segment. Pile of the eyes brown, that of the face gray, some dark pile on the occiput and that of the thorax and abdomen copious, long, grayish yellow; pile of femora yellow, of the tibiae and tarsi darker costally, veins and stigma brown, the anteriors darker than the posteriors; r-m crossvein about equal in length to the basal parts of the Rs.

"*Male Genitalia.*—Genitalia quite bare with but sparse yellow hairs. Superior plate (ninth tergum) broad, its posterior margin deeply concave, the cleft extending about two-thirds the length of the segment. Stylus narrow and pointed.

"Female.—The female differs in having shorter, all pale pile and the coxae and trochanters rufous; the pleurae sometimes has slight rufous markings. Wings more yellowed.

"Length of wing 4.5-6 mm."

Type locality: Granger, Utah.

Type in the United States National Museum.

Added distribution: Pullman, Washington and Paradise Valley Mt., Rainier, Washington, Aug. 30, 1928 (M. D. L.)

Bibio knowltoni var. *paltidus* Hardy

(Plate XXXIX, fig. 195a)

Bibio knowltoni var. *paltidus* Hardy, 1937, Proc. Utah Acad. Sci. XIV, 203.

Following is the original discussion of this variety with additional notes on the leg characters for the species:

"This variety differs from *knowltoni* in that the wings are dusky to smoky hyaline and not yellow fumose, the veins and stigma black, somewhat lighter basally. Males are much more densely pilose, and the pile of the body and coxae chiefly gray. Posterior legs of male red instead of yellow as in the preceding variety."

Subsegments of posterior tarsi rather short and broad, metatarsi three and one-half to four times as long as wide and about twice as long as tibial spurs (fig. 195a). Posterior femora average 2 mm. in length, posterior tibiae 1.7 mm.

Type locality: Provo, Utah.

Type in Brigham Young University Collection, Provo, Utah.

The species has been identified from numerous localities in Utah.

Bibio labradorensis Johnson

Bibio labradorensis Johnson, 1929, Diptera of Labrador, Psyche, vol. XXXVI, No. 2, 133.

This species is related to *monstri* James but is distinguished by the hyaline wings and the yellowish pile on the thorax.

MALE.—Head and appendages, body (except pale humeral ridges), coxae, trochanters and femora black; tibiae and tarsi chiefly yellow; anterior tibiae and three apical joints of tarsi somewhat brownish. *Legs:* Inner spurs of anterior tibiae short, not more than one-third to one-fourth the length of the outer; posterior femora and tibiae clavate, tarsal joints swollen, the metatarsi very noticeably enlarged and cylindrical. Pile of the head chiefly brown, some gray pile on the face; that of body and legs yellowish. *Wings:* Hyaline, anterior veins and stigma light yellow to brownish, posterior veins concolorous with the membrane; crossvein r-m about equal in length to the basal section of the posterior branch of radius.

Length of wing, 6 mm.

Female unknown.

Type locality: Nain, Labrador.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been observed from Camp 327, Alaska. Alaska Engineer Commission, 5-11-12, (J. M. Aldrich); Alberta, Canada, and Bedley, B. C., July 25, 1923 (C. B. Garrett).

Bibio lobatus Hardy

Bibio lobata Hardy, 1937, Proc. Utah Acad. Sci. XIV, 203.

This species is somewhat related to *knowltoni* Hardy but is distinguished by the yellow to red coxae and trochanters, the yellowish anterior portion of mesonotum and the pale tinge to the pleurae and abdomen. Following is the original description:

"*Female.*—Head chiefly black, appendages yellow-brown; meta and mesonotum black, tinged with yellow on the posterior margin, pronotum yellow on its lateral margins, marked with dark brown to black above; humeral ridges bright yellow; pleurae and abdomen yellow-red; legs, except darker yellow-brown anterior tibiae, bright yellow, segments slightly brownish tipped. Inner spurs of front tibiae short, one-third to one-fourth the length of the outer; front femora strongly swollen, hind femora clavate; hind tibiae straight, posterior basitarsi two times the length of the next segment. Pile short, sparse and yellow, except for some darker hairs on the tibiae and tarsi. Knobs of halteres ochraceous, stems yellow. Wings

slightly yellow fumose, veins and stigma yellow to light brown; r-m crossvein about equal to basal part of the Rs.

"Length of wing, 6.5-7.5 mm.

"Male unknown."

Type locality: Sierra Co., California.

Type in American Museum of Natural History.

Bibio longipes Loew

(Plate XXXIX, figs. 196a-b)

Bibio longipes Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 12, Compl. Work, 217-218.

This species is related to *slossonae* Cockerell but has the thorax and legs pale haired. This is one of the few species of Bibio which occur in the fall of the year.

MALE.—Usually entirely shining black, except for pale humeral ridges and tibial spurs; in some specimens the posterior tibiae and tarsi are rutilous. Pile of head copious, brown to black, that of body pale yellow to reddish. *Legs:* Inner spurs of anterior tibiae very short, not over one-fourth the length of the outer; each inner spur sharply pointed; outer spur extends about one-third the length of the long slender metatarsus (fig. 196a). Hind legs elongate, femora and tibiae clavate; posterior metatarsi swollen and cylindrical, about three times as long as wide, spurs of hind tibiae acute (fig. 196b). *Wings:* Hyaline to slightly yellow fumose, veins and stigma brown, the anteriors darker; crossvein r-m equal to basal part of the posterior branch of radius.

FEMALE.—The female differs in having the entire thorax, coxae and succeeding leg joints yellow to rufous (last three tarsal joints somewhat brownish). Abdomen sometimes tinged with rufous. Wings more yellow fumose. Pile all pale and shorter.

Length of wing, 5.3-5.6 mm.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been examined from the following states and Canadian provinces: Alberta, Colorado, Manitoba, Maryland, Massachusetts, Minnesota, New Brunswick, New York, North Carolina, Nova Scotia, Ohio, Ontario, Utah, Virginia and Washington. It has also been reported from Arizona and New Jersey.

The specimens from Utah and Colorado have the dorsum of female discolored with blackish.

Bibio melanopilosus Hardy

(Plate XXXIX, figs. 197a-c)

Bibio melanopilosus Hardy, 1936, Proc. Utah Acad. Sci. vol. XIII, 195.

This species differs from *curtipes* James in that the pile and legs are entirely black, legs never extensively yellow.

MALE.—Chiefly shining black, except for a slight tinge of reddish-brown on the humeral ridges and the rufous tibial spurs. Pile chiefly black, with a few yellow hairs intermixed on the dorsum. *Legs:* Rather short; inner spurs of front tibiae very short, not over one-fifth to one-fourth the length of the outer; hind femora clavate, tibiae hardly so; posterior metatarsus not swollen and less than twice the length of the next subsegment. Metatarsus one-third to one-fourth as wide as long; spurs of hind tibiae very flat, blunt and rounding (fig. 197b); hind femora average, 2.0 mm. in length, hind tibiae 1.8 mm. *Wings:* Dusky hyaline, slightly darker costally, subcostal cell brownish fumose. Veins and stigma dark brown, posteriors not so dark as the anteriors; r-m crossvein one-fourth the length of the basal part of Rs. Basal portion of m-cu crossvein and median portion of m partially interrupted (fig. 197a).

FEMALE.—The female differs in having shorter, less dense pile with some grayish pile on the abdomen and the face. Wings more dusky, veins and stigma blackish. Legs tinged with rufous, front femora strongly swollen and rutilous. Hind femora average 1.7 mm. in length, tibiae, 1.5 mm.

Length of wing, 5-6 mm.

Type locality: Spanish Fork, Utah.

Type in Brigham Young University Collection, Provo, Utah.

The species has been observed to be especially common in Utah County, Utah (it is the most abundant species found in the vicinity of Spanish Fork and Provo, around the last of April), and has been examined from numerous localities in Utah.

Bibio melanopilosus var. *biseptus* Hardy

Bibio melanopilosus var. *bisepta* Hardy, 1937, Proc. Utah Acad. Sci. XIV, 204.

Following is the original description:

"*Male.*—Entirely shining black, except slightly tinged tibial spurs, with pale yellow to gray pile on the body, coxae and femora; eyes black pilose; face chiefly gray; tibiae and tarsi black haired. Pile of the dorsum short and sparse, otherwise quite long and more copious. Inner spurs of front tibiae not over one-fourth the length

of the outer; posterior femora clavate, tibiae straight or nearly so; posterior metatarsus not swollen, first segment about one and one-half the length of the succeeding segment. Wings dusky hyaline, smoky costally; veins and stigma black, anteriors darker than posteriors; r-m cross-vein about one-fourth the length of Rs. Palpi four jointed, the second joint enlarged, larger than the others. First two joints of antenna smaller in width than succeeding segments, although equal in length.

"*Female.*—The female differs in having generally shorter pile (all pale on the head), propleurae with a fringe of long yellow hairs, and the wings more dusky. Anterior tibial spurs of the female are often entirely black.

"The adults of this species were taken in large numbers on *Dactylis glonerata* L. and the larvae were found in the roots of this grass. The adults were observed for a period of several hours but they gave no indication of feeding."

Type locality: Brigham Young University Campus, Provo, Utah.

Type in Brigham Young University Collection.

This variety is common in Utah.

Bibio mickeli Hardy

Bibio mickeli Hardy, 1927, Proc. Utah Acad. Sci. XIV, 204-205.

This species is related to *femoratus* Wied. and to *utahensis* Hardy, it is distinguished by the pale posterior veins of the wing and by the rufous coxae and trochanters of the females. Following is the original description:

"*Male.*—Entirely shining black, except for yellow humeral ridges, rufous tibial spurs, yellow bases of metatarsi and sometimes a slight tinge of red on the tibiae. Pile of head black, that of face very dense; pile of body, coxae and femora pale yellow, long, and copious; that of the tibiae and tarsi chiefly black and more bristly. Inner spurs of front tibiae long, almost as long as outer; hind femora and tibiae clavate; hind basitarsi not swollen, at least twice as long as second tarsal segment. Wings hyaline, anterior veins and stigma dark brown, posterior veins concolorous with the membrane; cross-vein r-m equal in length to the basal part of the Rs.

"*Male Genitalia.*—Coxites broad, genital cleft over one-third the length of the segment. Styli narrow and tapering. Superior plate gently concave, cleft not over one-fourth the length of the tergite. Pile of genitalia yellowish to reddish, longer pile on posterior margin of ninth sternite.

"*Female*.—The female differs in having shorter pile, yellow on the head; coxae (at least anterior pair), trochanters and femora rufous; wings yellow-brown fumose, anterior veins and stigma black, posteriors brown.

"Length of wing, 8-9 mm."

Type locality: Prontenac, Minnesota.

Type in University of Minnesota Collection.

Species is now known from the following states and Canadian province: British Columbia, California, Utah and Wyoming.

Bibio monstri James

(Plate XXXIX, figs. 198a-c)

Bibio monstri James, 1936, Amer. Mus. Novit. No. 832; 3.

This species is related to *labradorensis* Johnson but is distinguished by the black femora and black pile of the thorax.

MALE.—Head, thorax, abdomen, coxae, trochanters, femora and apical three tarsal joints black; tibiae and basitarsi yellow to rufous with dark tips, anterior tibiae somewhat darker, usually with black markings. *Legs:* Inner spurs of front tibiae not over one-fourth the length of the outer; posterior femora and tibiae clavate, the latter strongly so; posterior basitarsi swollen and longer than succeeding two subsegments. Pile of head, dorsum of thorax, coxae, trochanters, middle and front femora black; posterior femora, all tibiae and tarsi grayish to yellow pilose; pile of pleurae and anterior part of abdomen gray to blackish, yellow-gray to whitish on abdomen posteriorly. *Wings:* Chiefly hyaline with a slight tingle of yellow fumosity, darker costally; anterior veins yellow to brown, stigma pale yellow, posterior veins concolorous with the membrane; crossvein r-m about one-half the length of the basal part of Rs. *Genitalia:* The cleft of the ninth sternum extends about one-third the length of the segment; the distal portion of the sternum with characteristic patches of long hairs on outer edges, otherwise rather sparsely pilose (fig. 198a). Harpagones narrow (fig. 198b) and chiefly light colored, with a black spot basally. Ninth tergum deeply cleft, the cleft extending about three-fourths its length (fig. 198c).

Length of wing, 5.6-6 mm.

FEMALE.—The female differs in having the wings more yellow fumose, femora rufous and the pile short, yellow to reddish. This is the first report of this sex.

Type locality: Trail Ridge Road, Rocky Mountain National Park, Colorado, 12,200 feet. Paratypes were from Estes Park, Au-

gust, 1892 (Snow). The writer has examined a series of paratypes and specimens from Pikes Peak, Colorado, August 8, 1904; Mt. Audubon, Colorado, 7-20-36 (Alexander), and Logan, Utah, 5-5-37 (F. C. Harmston). The type is in the American Museum of Natural History.

Bibio necotus Hardy

Bibio necotus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 205-206.

This species is characterized by the elongate inner spurs of front tibiae and the short radio medial crossvein. It is the only species known to the writer that possesses this combination of characters. Following is the original description:

"*Male.*—Chiefly shining black except for a slight tinge of rufous on the humeral ridges, tibial spurs and tibiae. Pile very dense, long and brown to black. Inner spurs of front tibiae but little shorter than outer spurs; posterior femora and tibiae slightly clavate; hind metatarsi not enlarged, about twice as long as succeeding segment. Wings hyaline, anterior veins and stigma brown, posterior veins pale brown to yellow; r-m cross-vein about one fourth the length of the basal part of the Rs.

"Length of wing, 7.5-9 mm.

"*Female.*—The female differs in having shorter, more sparse and yellow-gray pile on the thorax and abdomen. Posterior tibiae not clavate. Otherwise fitting the description of the male."

Type locality: San Francisco, California. Larval host plant, *Erigeron glaucus.*

Type in Cornell University Collection.

Added distribution: Pullman, Washington, and Berkeley, California, March 16, 1931.

Bibio neojacobi n. n.

Bibio jacobi Hardy, 1938, Can. Ent. LXX, 209. Name preoccupied by *Bibio jacobi* Villeneuve, 1924, Encyc. Ent. Dipt. I, 5.

This species is related to *atripilosus* James but is distinguished by its yellow-brown fumose wings. Following is the original description:

"*Male.*—Head, thorax (excepting yellowed humeral ridges) and abdomen black. Pile of head chiefly black, with some gray hairs on the face, that of thorax and abdomen yellow. Legs chiefly shining black with the bases of the tibiae and basitarsi yellowish, spurs rufous. Anterior femora strongly swollen, inner spurs of anterior tibiae short, approximately one-third the length of the outer. Pos-

terior femora and tibiae clavate. Posterior basitarsi not strongly swollen and rather elongate, twice as long as second tarsal segment. Pile of coxae, trochanters and femora yellow, that of tibiae and tarsi chiefly brown to black. Wings yellow brown fumose, r-m crossvein equal in length to the basal part of the radial sector. Posterior veins and stigmata brown, anterior veins yellow to yellow brown. Humeral crossvein obsolete and interrupted, being but a short pale stump arising from the subcostal vein.

"Length of wing, 7-7.5 mm.

"Female unknown."

Type locality: Dunn Peak, British Columbia.

Type in Canadian National Museum.

Bibio neojacobi var. *rufitibialis* Hardy

Bibio jacobi var. *rufitibialis* Hardy, 1938, Can. Ent. LXX, 209-210.

This variety differs from the typical in having the base of femora rufous with apices brunneous and the tibiae and first two to three subsegments of tarsi chiefly rufous.

Male genitalia: Ninth sternum rather broad, cleft a little over one-third its length; harpagones slender, acute at apices. Ninth tergum with a U-shaped cleft on hind margin, extending two-thirds its length. Pile of genitalia brown to black.

Type locality: Dunn Peak, B. C.

Type in Canadian National Museum.

Bibio nervosus Loew

(Plate XXXIX, figs. 199a-c)

Bibio nervosus Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 4. Compl. work, 214.
Bibio variabilis Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 7. Compl. work, 215-216. Type in Cambridge Museum.

Comparison of Loew's types of *nervosus* and *variabilis* proved these to be conspecific and the name *nervosus* is given page priority. McAtee[73] states that *nervosus* Loew is very similar to *xanthopus* Wied. but differs in having duskier wings and broader front tibiae, it actually runs into the group having the inner spurs of front tibiae elongated, almost equal to the outer in length. It is distinguished from *xanthopus* by the long inner spurs.

MALE.—Head, body, coxae and femora (for the most part) black; the middle and hind femora often rufous basally, sometimes femora almost entirely rufous; middle and hind tibiae and first one to three joints of all tarsi, rufous basally and dark apically, the last two to

73. 1921, Proc. U. S. N. M. 60, Art. II, 13.

three tarsal joints usually entirely dark. *Legs:* Inner spurs of anterior tibiae relatively long, being but slightly shorter than the outer (fig. 199c); posterior femora and tibiae slightly clavate, posterior basitarsi not enlarged, twice as long as second tarsal subsegment. Pile usually gray to black rather long and dense, some specimens have chiefly yellow pile on the dorsum. *Wings:* Hyaline, anterior veins and stigma brown, posteriors concolorous with the membrane; crossvein r-m equal in length to basal part of Rs. *Genitalia:* Pile of genitalia mostly long and dark with some yellow hair intermixed. Ninth sternum broad and short, cleft extending a little over one-third the length of the segment (fig. 199b). Harpagones comparatively narrow and apparently pointed from the ventral view. Ninth tergum cleft to about its middle, and V-shaped (fig. 199a).

FEMALE.—The female differs in having shorter, all yellow, pile; all leg joints rufous with dark tips (coxae sometimes dark), and the wings yellow to yellow-brown fumose.

Length of wing, 6.5-10 mm.

Type locality: Sitka, also New Hampshire specimen in type series.

Type in Cambridge Museum of Comparative Zoölogy.

The species is more common in the western portion of the United States but has a rather wide range. The writer has studied the type series and has identified specimens from the following states, possessions and provinces: Alaska, Alberta, British Columbia, California, Idaho, Kansas, Manitoba, Michigan, Missouri, Montana, New Brunswick, Newfoundland, Ontario, Oregon, Quebec, Utah and Washington.

Bibio nigrifemoratus Hardy

Bibio nigrifemoratus Hardy, 1937, Proc. Utah Acad. Sci. XIV, 206.

This species is related to *atripilosus* James but is distinguished by its smaller size, the dense black pile of the dorsum, shorter inner spurs of front tibiae, yellowish fumose wings and shorter radiomedial crossvein. Following is the original description:

"*Male.*—Head, body (except pale humeral ridges), coxae, trochanters and femora (for the most part) black; posterior and midfemora chiefly black or brownish red, usually slightly rufous apically; front femora with a longitudinal stripe of rufous down their middles; front tibiae rufous, except for darkened portion at the base of the spurs, mid and hind tibiae and joints rufous, slightly darker apically, other tarsal segments brownish. Inner spurs of

front tibiae very short, being but one-fifth to one-fourth the length of the outer; posterior femora and tibiae clavate, the latter slightly thicker; posterior basitarsi not swollen and two times as long as next segment. Pile of eyes and occiput copious, black, that of face gray to black; dorsum of thorax with long, black pile, intermixed with yellow, in a few cases the yellow pile is predominant; pile of pleurae, coxae and femora yellow to gray; that of tibiae and tarsi brown, with yellow hairs intermixed. Wings hyaline to slightly yellow fumose, or dusky, anterior veins and stigma dark brown, posterior veins light brown to yellowish gray; r-m crossvein one-half to equal in length to the basal part of the Rs.

"Length of wing 4.5-5 mm.

"*Female.*—The female differs in having all pile short and yellow, all femora yellow to rufous, anterior coxae slightly so, and the wings more dusky yellow fumose."

Length of wing, 5-5.5 mm.

Type locality: Monte Lake, British Columbia.

Type in Canadian National Museum.

Bibio nigrifemoratus var. *gilvus* Hardy

Bibio nigrifemoratus var. *gilvus* Hardy, 1937, Proc. Utah Acad. Sci. XIV, 206.

This variety differs in having the pile of dorsum entirely yellow, that of pleurae, coxae, femora and abdomen gray to yellow. Hairs of tibiae and tarsi reddish brown. Femora often tinged with reddish-brown at their apices.

Type locality: Ogden, Utah.

Type in the United States National Museum.

Added distribution: Idaho: Moscow (J. M. Adrich). Montana: East Shore, Flathead Lake, April 21, 1934 (R. D. Kichmann). Utah: Petersboro, April 27, 1938 (Knowlton, Hardy, Stains); Cache Jc., June 27, 1938 (Knowlton, Hardy, Stains); Kanosh, June 27, 1938 (Knowlton, Harmston); Trenton, April 27, 1938, on Alfalfa (Knowlton, Hardy); Centerville, April 27, 1939 (Knowlton, Harmston); Pleasant View, April 25, 1939 (Knowlton, L. D. Bischoff); Sardine Canyon, April 22, 1939 (Knowlton, L. D. Bischoff) and Mantua, April 22, 1939 (Knowlton, Bischoff).

Bibio nigripilus Loew

Bibio nigripilus Loew, 1864, Dipt. Amer. Sept. Indig., Cent. 5, No. 10, Compl. work, 214-215.

Bibio lucens Hardy, 1937, Proc. Utah Acad. Sci. XIV, 203-204. This appears to be a synonym. The original description states that the hind metatarsi are one and one-half times as long as next subsegments but the types have not been compared to see if this character is good.

MALE.—Head, body (except yellow humeral ridges), coxae and trochanters shining black. Femora, tibiae (front tibiae brownish) and tarsi yellow to rufous, all joints dark tipped. *Legs:* Inner spurs of front tibiae but slightly shorter than outer; posterior femora and tibiae clavate; posterior basitarsi not swollen, about two times as long as second tarsal subsegments. Pile of head and thorax chiefly black, long and copious; that of coxae gray to black; of the femora and succeeding leg joints yellow-red; the pile of the abdomen gray on the anterior half and yellow posteriorly. Knobs of halteres brown, stems ochraceous. *Wings:* Hyaline, slightly fumose costally; anterior veins and stigma brown, posteriors concolorous with the membrane; crossvein r-m almost as long as basal part of Rs.

Length of wing, 5-6 mm.

Female unknown.

Type locality: Winnipeg, Canada.

Type in Cambridge Museum of Comparative Zoölogy.

Specimens fitting the description of *nigripilus* have been examined from Great Falls, Virginia, IV-23-19 (C. T. Greene); Montreal, New York; Bellmore, Indiana, July 2, '89 (A. E. Thomas); C. Mo., May (C. V. Riley); Jackson, Minn., 28 May, 1907; Covey Hill, Que., 31-5-1924, (P. Armstrong) and Brookings, South Dakota, April 24, 1925 (N. C. Severin). *B. lucens* was described from Ontario and Minnesota.

Bibio painteri James

Bibio painteri James, 1936, Amer. Mus. Novit. No. 832, p. 2.

This species is very close to *alexanderi* James. The following is James' discussion of it with added notes on leg characters:

"Related to *alexanderi*. It differs as follows: The dorsum of the thorax, in the female, is extensively marked with black; the extent of the black is variable, and may cover the large part of the dorsum. The pile of the tibiae is pale in both sexes and similar to that of the femora. In the male, the posterior tibiae, as well as the femora are clavate. The eyes are black-haired, and there is usually a considerable amount of pale pile on the lower part of the occiput."

The inner spurs of front tibiae almost half as long as the outer,

the outer spurs extending less than half the length of the metatarsi. Inner spurs of hind tibiae rather blunt, outer ones slender and acute. Hind metatarsi less than four times as long as wide.

Length: body and wings, 4.2-4.7 mm.

Type locality: Manhattan, Kansas.

Type in American Museum.

The writer has studied paratopotypes and has identified specimens from Stillwater, Oklahoma, 3-25-39 (K. C. Emerson); Columbus, Ohio, 23-IV-34 (R. H. Painter) also from Arizona and Colorado.

Bibio pingreensis James

(Plate XXXIX, fig. 200a)

Bibio pingreensis James, 1936, Amer. Mus. Novit. No. 832, p. 4.

Following is the original description with added notes on the leg characters:

"Related to *inaequalis* Loew, but the posterior basitarsi are not so noticeably enlarged and the legs are differently colored; it is more robust than *longipes* and the structure of the posterior tarsi is different.

"*Male*.—Head, with appendages, thorax and abdomen black. Head wholly black-haired, the eyes with copious black hair. Thorax, abdomen, and legs with long yellowish pile; a little gray pile on the mesopleura; some short black pile on the tibiae and tarsi. Coxae, trochanters, femora and anterior tibiae black; the spurs on the anterior tibiae yellow, the inner spur one-third the length of the outer one; posterior femora strongly clavate, the constricted basal part yellowish; middle tibiae brown; posterior tibiae yellowish to brown; tarsi brown, the basitarsi yellowish to brown. Posterior basitarsi slightly enlarged, but cylindrical, rather than globular, as in the related species. Wings whitish or slightly grayish hyaline; the strong veins brown; the posterior ones barely discernible from the membrane; crossvein r-m about one-half as long as the basal section of vein Rs. Length, 7-8 mm.

Outer spurs of front tibiae extending less than half the length of the metatarsi. Spurs of middle tibiae slender and acute; outer spurs of hind tibiae acute, inner ones rather blunt at apices. Hind metatarsi more than three and one-half times as long as wide (fig. 200a). Hind femora average 3.4 mm.; hind tibiae 2.7 mm.

Type locality: Mummy Pass, Alpine Zone, Pingree Park, Colorado.

Type in the American Museum.

Specimens have been identified from Cameron's Pass, Colorado, Aug. 20, 1940 (R. H. Beamer) and Logan Canyon, Utah, 9-11-37 (G. F. Knowlton, F. C. Harmston).

Bibio rufalipes Hardy

Bibio rufalipes Hardy, 1937, Proc. Utah Acad. Sci. XIV, 207.

This species is related to *xanthopus* Wiedemann but is distinguished by the concolorous posterior veins of wing, the reddish markings on the thorax and abdomen of the males and the wholly rufous thorax and legs of the females.

Following is the original description:

"*Male*.—Head chiefly black, appendages brownish; pile of eyes short and brown, that of face long, copious gray. Dorsum of thorax, for the most part, black, humeral ridges yellow, posterior margin rufous; pleurae with some rufous markings or tinges of reddish. Abdomen black, except lateral margins of tergites which are reddish. Pile of thorax and abdomen long, grayish yellow, more yellow hair on the posterior part of the abdomen. Coxae and trochanters somewhat tinged with red or reddish-brown; femora, tibiae (except more brownish anterior tibiae) and first two to three tarsal joints of legs chiefly yellow, with some darker hairs on the tibiae and tarsi. Inner spurs of anterior tibiae very short, not over one-fourth the length of the outer; posterior femora and tibiae clavate, the latter rather strongly swollen, larger than the femora in width; posterior basitarsi not enlarged, about as long as next two segments. Wings slightly yellow-fumose, anterior veins and stigma yellow-brown, posterior veins concolorous with the membrane; cross-vein r-m about equal in length to the basal part of the Rs.

"*Female*.—The female differs in having the entire thorax, coxae and trochanters rufous, the abdomen testaceous, or with a reddish cast; the tibiae and tarsi darker in coloration than the femora, those of the anterior legs dark red-brown to black, other tibiae and tarsi darker rufous to brown. All pile shorter and yellow, and wings darker fumose.

"Length of wing, 6-6.5 mm."

Type locality: Waco, Texas.

Type in United States National Museum.

Bibio rufithorax Wiedemann

(Plates XXXIX-XL, figs. 201a-f)

Bib-(io) rufithorax Wiedemann, 1828, Ausz. Zweifl. Ins. 1, 78.
Bibio thoracica Say, 1824, Expd. to St. Peters Riv. vol. 2, 368, 1859, Compl. writ. vol. 1, 250.

These are probably the same species but as Say's type is lost Wiedemann's name is used.

Doctor Max Beier of the Wein Museum kindly made comparative studies of Wiedemann's type so this species can now be accurately placed.

This species is related to *Bibio carolinus* Hardy and the females of these have heretofore been considered one species. The males key out near *longipes* Loew by having the posterior basitarsi swollen but otherwise they are very different from this species. It differs from *carolinus* by having the posterior basitarsi of male swollen (fig. 201e); in both sexes only the posterior portion of humeral ridges are yellow and the mesonotum has three characteristic, broad, finely shagreened areas. The pleurae are more densely pale haired; and the vertex has shorter hairs behind the ocelli in the male; *carolinus* has very elongate hairs on this portion of the head. The sides of scutellum and upper lateral margins of metanotum are ruficent in *carolinus* males, entirely black in *rufithorax*. The females differ markedly in that the length of the head behind the eyes is much shorter than the length of the eyes (fig. 201b) instead of longer than the eye length (fig. 187a), and no tubercles are present in the middle of the face behind the antennae as in *carolinus*. Head and prothorax finely shagreened, giving a dull appearance; entire head and prothorax of *carolinus* brightly polished, chiefly smooth. The propleurae with characteristic vertical striations, somewhat concentrically arranged. The head, propleurae, mesopleurae and sternopleurae more densely pale haired in *rufithorax*, almost bare in *carolinus*. The specimens of both sexes are also larger in size and the male genitalia are very different.

MALE.—In addition to the above characters the males are almost entirely black. *Head:* Compound eyes are divided into an upper and lower portion by a transverse indentation near the lower margins; the pile of the eyes is rather dense and brown in color, that of face chiefly yellow. Antennae nine segmented, the segments rather closely compacted; first segment (scape) is about equal to the third in length, the second (pedicel) is almost two times as long as the scape. *Thorax:* Mesonotum with three broad, dull vittae, brought

about by a shagreened condition of the cuticula; the median vitta extends almost the entire length of the mesonotum, less distinct in front and behind; the lateral vittae are separated from the median by a polished stripe on each side and from the lateral margin by another broader shining stripe. Halteres brownish, with a faint tinge of yellow. *Legs:* Entirely shining black, front tibiae long and slender, equal to femora in length, inner spur much less than one-half the length of the outer (fig. 201d). *Wings:* Brown fumose on anterior margin, yellow on posterior; anterior veins and stigma brown, posterior veins yellow-brown. Crossvein r-m equal in length to the basal portion of vein M_{1+2}, situated well before the branch of M_{3+4}. Cubital vein ending much before the wing margin, anal vein not extending much beyond the base of m-cu crossvein (fig. 201a). Veins in posterior portion of wing, although lighter in color are much thicker than anterior veins. Abdomen rather thickly pale pilose. *Genitalia:* Ninth sternum with a median cleft over one-third its length, and a moundlike gibbosity in the middle of the cleft; sternum broader than long. Harpagones rather short, bent down into a blunt beaklike process apically (fig. 201c). Ninth tergum deeply V-shaped cleft, about two-thirds its length (fig. 201f).

Length of wings, 11-11.4 mm.

Type locality: Pennsylvania.

Type in Vienna Museum.

Specimens have been examined from South Port, North Carolina, April, 1934 (Harris-Wray); Winnabow, N. C., 4-15-1937 (Harris-Wray); Virginia Beach, Virginia, May 17, 1907 (I. J. Condit); it also has been reported from Washington, D. C., South Carolina, Texas and Florida.

Bibio sericatus Hardy

(Plate XL, figs. 202a-b)

Bibio sericata Hardy, 1937, Proc. Utah Acad. Sci. XIV, 207.

This species is related to *longipes* Loew but is easily separated by the pale stigma and almost obsolete posterior veins, by the blunt tibial spurs and shortened subsegments of tarsi. Following is the original description with additional notes on the leg characters:

"*Male.*—Chiefly shining black, except rufous tibial spurs, yellow humeral ridges and sometimes slight tinge of rufous on the tibiae and basitarsi. Pile of eyes black, that of face gray to brown; that of body and legs for the most part yellow, somewhat reddish-yellow on tibiae and tarsi. Inner spurs of front tibiae short, about one-fourth the length of the outer; posterior femora clavate, tibiae hardly

so; segments of posterior tarsi swollen and rather globular; basitarsi conspicuously swollen and more short (not so elongate as *longipes*), being about one and one-half times as long as the next segment. Wings slightly yellow fumose, darker costally; anterior veins dark brown, stigma yellowed, almost obscure; posterior veins concolorous with the membrane, or but slightly more yellowed; crossvein r-m equal to basal part of Rs."

The inner spur of front tibia is blunt, somewhat rounding at its apex, the outer is about as thick as the metatarsus and extends about half its length (fig. 202a). The spurs of hind tibiae are blunt and thick, especially the inner spur; the posterior metatarsus is scarcely over twice as long as wide (fig. 202b).

"*Female.*—The female differs in having only the coxae and trochanters of the legs black, the other joints being yellow to rufous, and in having all pile short, sparse and yellow.

"Length of wing, 4.5-5.5 mm."

This species occurs in the late summer and early fall.

Type locality: Mt. Rainier, Washington.

Type returned to Mr. J. Wilcox, Alhambra, California.

Added distribution: Yahk, Lamb Creek, B. C., Aug. 9, (C. Garrett); Oliver, B. C., Aug. 27 (C. Garrett); Cranbrook, B. C., Sept. 29 (C. Garrett).

Bibio similis James

Bibio similis James, 1936, Amer. Mus. Novit. No. 832,.5.

This species approaches rather closely to *albipennis* Say but is distinguished by the longer r-m crossvein in the wing.

MALE.—Shining black, except for reddish tibial spurs and yellowed bases of metatarsi. Pile of head gray to black, that of body, coxae and femora chiefly pale yellow, a few long, gray hairs on the anterior portion of the abdomen; tibiae and tarsi with short black and pale hairs intermixed. *Legs:* Inner spurs of anterior tibiae short, not over one-fourth the length of the outer; posterior femora and tibiae clavate, posterior basitarsi not swollen, about twice as long as next tarsal subsegments. *Wings:* Whitish hyaline, anterior veins and stigma black, posterior veins somewhat lighter, r-m crossvein almost as long as the basal part of the posterior branch of radius.

Length of wing, 7-8 mm.

Female unknown.

Type locality: Boulder, Colorado.

Type in the American Museum.

James also reports this species from Rifle, Colorado, and Fort

Duchesne, Utah. The writer has identified specimens from Ft. Collins, Colorado; South Fork, Provo Canyon, Utah (Hardy); Logan Canyon, Utah, 5-16-34 (Thatcher); Plain City, Utah, 5-6-35 (G. F. Knowlton) and Logan, Utah, 5-26-33 (Thatcher).

Bibio slossonae Cockerell

Bibio slossonae Cockerell, 1909, Fossil Insects from Colorado. The Entomologist, vol. 42, p. 174. Change of name for *B. gracilis* Walker.
Bibio gracilis Walker, 1848, (nec Unger), List Dipt. Ins. Brit. Mus., vol. 1, 123.

This species is related to *longipes* Loew but is distinguished by the black pile of the male and black dorsum of thorax of female.

MALE. — Head and appendages, thorax (except pale humeral ridges) and abdomen shining black; the legs dark reddish-brown to black, with a few yellowish hairs intermixed on the femora. *Legs:* Inner spurs of front tibiae short, one-third to one-fourth the length of the outer; posterior femora clavate, elongate; posterior basitarsi greatly swollen. *Wings:* Yellow fumose to yellow hyaline; anterior veins and stigma brown, posterior veins more yellowish; r-m cross-vein slightly longer than the basal part of Rs.

Length of wing, 4.7-5.3 mm.

FEMALE.—The female differs in having all hair short and pale; the legs yellow to rufous, slightly darkened apically, and the pleurae usually tinged with rufous.

Type locality: Nova Scotia.

Type in British Museum.

Specimens have been examined from Alberta, British Columbia, California, Colorado, Manitoba, Michigan, Minnesota, Newfoundland, New York, Saskatchewan, South Dakota, Wisconsin and Wyoming.

Bibio tenellus Hardy

Bibio tenella Hardy, 1937, Proc. Utah Acad. Sci. XIV, 208.

This species is related to *pingreensis* James and is distinguished by the dark yellow fumose wings and the reddish-brown apices of femora. Following is the original description:

"*Male.*—Head, body (except pale humeral ridges), coxae and trochanters black; front femora chiefly black with but slight rufous tinge; middle and anterior femora dark reddish-brown on the apical half and slightly yellowed on the basal constriction; middle and hind tibiae and the first two segments of all tarsi yellow, darkened apically; last three tarsal segments dark brown to black; anterior tibiae yellowed basally, dark brown medianly; tibial spurs rufous to yel-

low. Inner spur of front tibiae very short, one-third to one-fourth the length of the outer; posterior femora and tibiae clavate, tibiae slightly thicker than femora; posterior basitarsi distinctly elongate, not noticeably swollen or globular, at least two times as long as the second tarsal segment. Pile of eyes rather short and black, that of the face copious, brown, that of the thorax, abdomen and legs, for the most part, copious, long and yellow; tibiae and tarsi with some darker pile intermixed. Halteres yellow-brown, much lighter in color than thorax. Wings dark yellow-fumose, anterior veins and stigma yellowish-brown, posterior veins yellowed and concolorous with the membrane; r-m crossvein almost equal in length to the basal part of the Rs.

"Length of wing, 6-6.6 mm.

"Female unknown."

Type locality: Healy, Alaska.

Type in United States National Museum.

Bibio townesi n. sp.

(Plate XL, fig. 203a)

This species is related to *fluginatus* Hardy and *inaequalis* Loew. The males are readily distinguished by the bright yellow ninth sternum and harpago bases, yellow coxae and trochanters, sparsely pilose eyes and more hyaline wings. *B. fluginatus* Hardy has the r-m crossvein shorter to about equal to basal portion of vein Rs, crossvein r-m is distinctly longer than base of Rs in *townesi*. The females may be separated from *inaequalis* by their smaller size and smoky yellow wings.

MALE.—Eyes very sparsely covered with short pale pile, lower one-fourth of each compound eye divided off by a transverse depression. Antennae eight segmented, second segment (pedicel) yellowish. Face rather thickly gray pilose. Thorax chiefly shining black with scattered yellow hairs, sometimes the median portion of mesonotum is rufous in ground color. Humeral ridges and posterior margin of pronotum and propleurae pale yellowish. Halteres yellow-brown to black, stems more pale. *Legs:* Almost entirely yellow, apices of tibiae slightly darkened, spurs rufous; apical two to three tarsal subsegments faintly brownish. Inner spurs of front tibiae short, about one-third the length of the outer; outer spurs extend almost half the length of the metatarsi. Spurs of hind tibiae slender and acute. Posterior metatarsi distinctly thickened, about equal in width to the apex of the tibiae; metatarsi about four times as long

as wide and longer than next two subsegments. Femora and tibiae slender, posterior femora average 2 mm. in length, posterior tibiae average 1.7 mm. *Wings:* Hyaline with a faint yellowish tinge, stigma and anterior veins brown, posteriors brownish yellow, darker than membrane. Basal portion of vein Rs, shorter than crossvein r-m. Abdomen mostly shining black, lateral margins of terga often with a faint yellowish tinge. *Hypopygium:* Ninth sternum bright yellow, cleft extending almost half the length of the segment. Harpagones elongate and slender, gently curved downward (fig. 203a); bases yellow, otherwise brown to black. Ninth tergum gently concave on hind margin.

Length: body, 4.2-4.4 mm.; wing, 4.4-4.6 mm.

FEMALE.—Head rufous tinged in ground color, rather thickly covered with yellow hairs. Head behind compound eyes almost twice as long as the eye length. Thorax entirely yellow; posterior metatarsi slender and elongate; wings pale yellowish fumose. The abdomen is entirely yellow-brown with the sterna more distinctly yellowish.

Length: body, 4.4 mm.; wing, 5.5 mm.

Holotype male, Westerly, R. I., July 29, 1937 (N. Chapman). Allotype female, Hancock, N. Y., Aug. 11, 1935 (H. K. Townes). Two paratype males, same data as holotype; one paratype male, Canterbury, Connecticut, July 25, 1937 (N. Chapman) and five paratype males, Lake Mohonk, Ulster Co., N. Y., Aug. 1, 1936 (H. K. Townes).

Holotype, allotype and three paratypes returned to Doctor H. K. Townes, others retained in the Snow Entomological Collection.

Bibio tristis Williston

Bibio tristis Williston, 1893, in Kellogg, V. L., Insect notes, Trans. Kansas Acad. Sci. 113-114.

Related to *xanthopus* Wiedemann but distinguished by the dense black pile on the dorsum of thorax.

MALE.—Head, thorax (except yellowed humeral ridges), abdomen, coxae and trochanters black, with rather copious black pile. *Legs:* Femora, tibiae and tarsi chiefly rufous with dark tips; sometimes apical halves of femora and tibiae somewhat darkened; pile of legs gray to black, that of tibiae and tarsi shorter and darker than that of femora. Hind femora and tibiae clavate, hind basitarsi not swollen, about equal in length to next two subsegments. Inner spurs of front tibiae short, about one-fourth to one-fifth the length of the outer. *Wings:* Dusky hyaline, r-m crossvein almost equal in length

to the basal part of Rs. Anterior veins and stigma brown, posteriors brownish yellow.

FEMALE.—According to Williston the female has the pile chiefly black and has the middle and hind coxae in part black. It will probably key out near *xanthopus* but since this writer has not examined a female and the original description is rather meager its exact position is unknown.

Type locality: Western Kansas.

Location of type unknown. No specimens of the type series are at the University of Kansas or Kansas State College.

The species has been reported from Kansas and Graham Mts., Arizona. Males apparently belonging here have been examined from Pullman, Washington, 24 April, '01; Wellsville, Utah, 6-3-37 (F. C. Harmston) and Provo, Utah, V-9-37 (D. E. Hardy).

Bibio utahensis Hardy

Bibio utahensis Hardy, 1937, Proc. Utah Acad. Sci. XIV, 208-209.

This species is related to *mickeli* Hardy but is separated by the dark posterior veins and shorter inner spurs of front tibiae. Following is the original description:

"MALE.—Entirely shining black, except for pale humeral ridges and tibial spurs. Pile of the eyes black, that of face gray; of the thorax chiefly black; pile of coxae and femora gray to yellow; that of tibiae and tarsi black; of abdomen gray to black anteriorly, yellow posteriorly. Inner spurs of front tibiae about three-fourths the length of the outer; posterior femora and tibiae slightly clavate, posterior basitarsi not swollen, and rather elongate, as long as next two tarsal segments. Wings chiefly hyaline, slightly dusky anteriorly; anterior veins gray to brown; r-m crossvein one-half to equal the length of the Rs.

"Length of wing, 6-7 mm."

Female unknown.

Type locality: Provo River, Provo, Utah.

Type in Brigham Young University collection at Provo, Utah.

Additional distribution: Utah: Logan Canyon, May 15, 1938 (D. E. Hardy, A. T. Hardy); Richmond, May 13, 1938 (D. E. Hardy); Spanish Fork, May, 1938 (Knowlton, Hardy); Logan, May 8, 1938 (D. E. Hardy); Mantua, May 3, 1937 (G. F. Knowlton); Honeyville, April 29, 1939 (G. F. Knowlton, D. L. Bischoff); Washington: Pullman, May 6, 1899.

Bibio velcidus Hardy

Bibio velcida Hardy, 1937, Proc. Utah Acad. Sci. XIV, 209.

This species is related to *abbreviatus* Loew but is distinguished by having the pile of the body chiefly black and the legs dark reddish brown to black, the male genitalia have not been dissected. Following is the original description:

"MALE.—Head, body (except yellowed humeral ridges), coxae and trochanters shining black. Femora and succeeding leg joints dark reddish brown to black, slightly lighter basally; the constriction of the posterior femora and tibiae dark rufous; basal part of tarsal segments yellow. Spurs of front tibiae rufous, the inner spurs about three-fourths as long as the outer; posterior femora and tibiae clavate; posterior basitarsi not enlarged, not much over one and one-half times as long as the second tarsal segment. Pile chiefly black, long and copious; some yellow pile on the posterior half of the abdomen or sometimes sparsely intermixed on the thorax and femora. Wings slightly yellow fumose, anterior veins and stigma dark brown, posteriors light brown-yellow; crossvein r-m equal in length to the basal part of the Rs.

"Length of wing, 6-7 mm."

Type locality: Low Bush, Ontario.

Type in Canadian National Museum.

Bibio velorum McAtee

Bibio velorum McAtee, 1923, Proc. Ent. Soc. Wash., vol. 25, No. 3, 62.

This species appears somewhat related to *nervosus* Loew and is characterized by the rufous femora and the yellowish fumose wings. The following is the original description:

"Inner spur of front tibiae fairly long but still much shorter than outer; head, body and coxae black, humeral ridges yellowish; wings almost uniformly yellowish fumose; stigma small, blackish.

"*Male*.—Rather long erect hair on eyes, much longer hair of occiput and top of thorax dark, of sides of thorax, coxae and abdomen pale, grayish. Hind legs elongate, femora and tibiae clavate, metatarsi enlarged, the apices of all joints and whole of last two tarsal joints dark, remaining portions reddish, tibiae and tarsi brownish to black; hair of legs tending to agree in shade with integument from which it springs but that of front legs wholly dark grayish. Length of wing: 8-8.5 mm.

"*Female*.—Pubescence in general shorter and more bristly than in male but all tibiae and tarsi tend to be darker than the femora, all joints dark-tipped. Length of wing: 10-11 mm."

Type locality: Jefferson, North Carolina.

Type in the United States National Museum.

The writer has studied the type and has identified the species from Grandfather Mt. top, North Carolina, Oct. 8, 1936 (D. L. Wray). Specimens have also been seen that seem to belong here from Pingree Park, Colorado, 9,000 feet, August 19, 1929 (D. A. Wilbur) and Cameron Pass, Colorado, Aug. 21, 1940 (G. F. Knowlton).

Bibio vestitus Walker

Bibio vestita Walker, 1848, List. Dipt. British Mus., pt. 1, p. 122.

The original description does not mention the length of the inner spurs of front tibiae, so the identification of this species can not be positive.

The following description is taken from McAtee:

"Head, body, and legs black, clothed with black hairs, abundant and long over head, body, coxae and femora, shorter on remaining joints of legs; tibiae and tarsal joints rufous with dark tips, the last two joints of tarsi almost or wholly dark; front tibiae reddish brown, the spurs very unequal; wings nearly hyaline, stigma and anterior veins brown, the cells bounded by latter more obscure than remainder of wing, posterior veins almost hyaline. Length of wing, 7 mm."

Type locality: Nova Scotia.

Type in British Museum.

McAtee reports this species from St. John, New Brunswick, June 9, 1901 (W. McIntosh). The author has a male specimen from Mirror Lake, Uintah Mountains, Utah (Hardy) which fits the above description very well.

Bibio xanthopus Wiedemann

(Plate XL, fig. 204a)

Bib (io) xanthopus Wiedemann, 1828, Ausz., Zweifl. Ins., I, 80.

Bibio canadensis Macquart, 1838, Dipt. Exot. i, 129. Questionable synonomy, original description is inadequate.

Bibio scita Walker, 1848, List Dipt. Brit. Mus. Pt. 1, 122. Questionable synonomy based only upon description.

Bibio humeralis Walker, 1848, List Dipt. 1, 121-122. Questionable synonomy based only upon description. See note on *B. macateei* James.

Bibio lugens Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 5, Compl. Work, 214-215. New synonomy based upon study of type No. 12518 in Cambridge Museum.

Bibio obscurus Loew, 1864, Dipt. Amer. Sept. indig., Cent. 5, No. 5, Compl. Work, 124. New synonomy based upon study of type in Cambridge Museum.

Bibio macateei James, 1936, Amer. Mus. Nov. 832, 4. New synonomy based upon examination of holotype and allotype in American Museum.

McAtee suggested that *obscurus* Loew was probably the same as *xanthopus*. Examination of the type No. 12521 in the Cambridge Museum of Comparative Zoölogy proved this assumption to be cor-

rect. The type differs from typical *xanthopus* only in having the wings more lightly fumose and the posterior veins not so dark, there are such variations, however, in the fumosity of the wings of this species that this cannot be considered a specific character.

Doctor James states *macateei* "is apparently the species which McAtee refers, with a query, to *humeralis* Walker" as Walker's species is unidentifiable from description he preferred to describe it as new. It is based upon the slightly paled anterior margin of mesonotum of the female, the specific variations through a series of *xanthopus* shows this to be an intergrading factor. This synonomy must therefore include *humeralis* although examination of Walker's type may prove it to be distinct.

Bibio xanthopus is related to *nervosus* Loew but is distinguished by the shorter inner spurs of front tibiae.

MALE.—Head, body (except yellow humeral ridges) and coxae black, femora and succeeding leg joints yellow to rufous with dark tips, the tibial spurs rufous. *Legs:* Inner spurs of front tibiae short, about one-third to one-half the length of outer spurs; outer spurs extending but little over one-third the length of the front metatarsi (fig. 204a). Posterior femora and tibiae slightly clavate, hind metatarsi not swollen, about twice as long as second subsegment of tarsi and five times as long as wide. Apical spurs of hind tibiae slender and acutely pointed. *Wings:* Hyaline to yellow fumose, anterior veins and stigma dark brown, posterior veins more pale. Crossvein r-m about equal to the basal portion of vein Rs.

FEMALE.—Differs in having shorter, all pale pile, wings darker fumose and coxae and pleurae usually in part rufous or tinged with brown.

Length of wing, 5.5-9.5 mm.

Type locality: New York.

Type in Vienna Natural History Museum.

This is an exceedingly variable species and many of its intergrades present rather complex problems. It is widely distributed, having been identified from most all of the states and Canadian provinces, it is one of the most common Bibionidae in the Northern states.

Bibio xanthopus palliatus McAtee

Bibio xanthopus palliatus McAtee, 1921, U. S. N. M., v. 60, Art. 11, p. 16.

Bibio signatus Hardy, 1937 Proc. Utah Acad. Sci. v. XIV, 208. New synonomy based upon study of *xanthopus palliatus* type.

At the time *signatus* was described the writer was only acquainted with the typical forms of *xanthopus* (those having the inner spur of front tibiae short), *signatus* was proposed for that group having the

inner spur about equal to the outer in length. Since then all stages of intergrades between the two have been examined proving that these are not distinct species; examination of McAtee's type established this as a synonym of his subspecies.

This subspecies has caused a great deal of controversy because of the variability of the species. The following is McAtee's discussion of it: "Differs from the typical subspecies in darker colors, more abundant pubescence, and somewhat greater average size. The pleura of the female usually are wholly dark. The male has more abundant, longer, and darker hair, sometimes wholly black. This subspecies bears somewhat the same relation to the eastern race of *xanthopus* that *hirtus* does to *albipennis*.

"Length of wing, 7.5-9.5 mm."

The inner spurs of front tibiae vary from one-third the length of the outer as in typical *xanthopus* to almost as long as the outer as characterize the *signatus* form, this makes it necessary to key this subspecies in two different groups. Specimens are usually dusky winged and have been known as *nervosus* Loew. Mr. P. C. Ting states that the larvae of *xanthopus* and *xanthopus palliatus* are quite different, he informed the writer (and has kindly submitted mounted specimens for study) that the dorsum of the anal segment is heavily sclerotized on specimens of *palliatus* and the spinules are elongate (fig. 119a), while the larvae of *xanthopus* consistently lack the heavy sclerotization on the dorsum of the anal segment and the body spinules have more teeth and their bases are short and broad (fig. 118a).

Type locality: Moscow, Idaho.

Type in the United States National Museum.

This subspecies is very common in the west, having been identified from numerous localities in the following states and provinces: British Columbia, California, Idaho, Nevada, Oregon, Utah and Washington.

SPECIES NOT IDENTIFIABLE, DESCRIPTIONS INADEQUATE

Bibio brunnipes (Fabricius), 1794, Ent. Syst. 4, 250 (Tipula). Described from Newfoundland.

Bibio castanipes Jaennicke, 1867, Neue exotische Dipteren, ab. d. senckenb, naturf. Gesellsch. 6, 317. Described from Illinois.

Bibio orbatus Say, 1823, Journ. Acad. Nat. Sci. Phil. III, 78, 1859. Comp. writings II, 69-70. Described from Pennsylvania and although it is not known just what Say had before him it is certainly not to be confused with *orbatus* of the genus *Philia* and *Philia orbatus*

(Wiedemann), 1826, Ausz. Zweifl. Ins. I. is a synonym of *Bibio orbatus* Say.

Bibio rufipes (Fabricius), 1781, Spec. Insectorum II, 410 (Tipula). Described from Newfoundland.

Bibio striatipes Walker, 1848, List. Dipt. Brit. Mus. I, 122-123. Described from St. Martin Falls, Albany River, Hudson Bay.

Bibiodes Coquillett

Bibiodes Coquillett, 1904, Proc. Ent. Soc. Wash. 6, 171.

The members of this genus are similar in many respects to the *Bibio*, they possess the strongly developed spurs on front tibiae but the inner spurs are always rather weak. The wing venation is very different and the two genera are best distinguished by this character. In *Bibiodes* the third longitudinal vein (the posterior branch of the radius) coalesces with the fourth vein (medius) for a short distance near the middle of the wing obliterating the radio-medial crossvein (fig. 205c). The harpagones of the males are characteristically bilobed and show good specific characters. The species are much smaller than any known *Bibio*, wing length averaging from 3.5-4 mm.

GENOTYPE: *Bibiodes halteralis* Coquillett

KEY TO THE SPECIES OF *Bibiodes*

1. Thickened portion of costal margin extending about half way from stigma to apex of wing; femora conspicuously swollen; antennae shorter.....*femorata* Melander, p. 495
   Thickened portion of costal margin extending much more than half way from stigma to apex of wing; legs less robust, antennae longer..... 2
2. Halteres yellow; tarsal joints slender; inner processes of harpagones strongly developed, longer than outer lobes (fig. 207a).....*halteralis* Coquillett, p. 496
   Halteres dark, at least apically; tarsal joints somewhat swollen; inner processes not strongly developed, about the same size as outer lobes (fig. 205a), *aestiva* Melander, p. 494

Bibiodes aestiva Melander

(Plate XL, figs. 205a-c)

Bibiodes astiva Melander, 1912, The Dipterous Genus Bibiodes, Bull. Amer. Mus. Nat. Hist., vol. 31, 438.

MALE.—Head and appendages, body, coxae, femora, anterior tibiae and tarsi, excepting tibial spurs, shining black with sparse, rather long pale hair, shorter and somewhat brownish on the tarsi. *Legs:* Anterior tibial spurs rufous, the inner spur much shorter than outer, being less than a fourth as long; tibiae and tarsi of the posterior legs yellowish or rufous to reddish brown, the joints darker apically; the tibiae of the mid-legs sometimes entirely black; posterior tarsi somewhat swollen. Stems of halteres pale, knobs black. *Wings:* Hyaline to slightly yellowish fumose, stigma and anterior veins dark

brown, posterior veins light yellowish brown, costal cell (submarginal) yellowish fumose. *Genitalia:* Pile of genitalia chiefly yellow; ninth sternum broad, posterior margin cleft about one-third the length of the segment, cleft broadly U-shaped. Aedeagus broad and blunt, appearing quite heavily sclerotized. Harpagones developed into two lobes (fig. 205a), the outer (main lobe) rather long and sharply pointed, more heavily sclerotized than the inner; the inner lobe is lighter in color and not so distinctly tapered. The two lobes are very nearly equal in size, although very different in shape. Ninth tergum gently convex on both margins and about twice as broad as long. Cerci with but slightly rounded edges, almost square in shape (fig. 205b).

Length of wing, 3.5-4 mm.

Female unknown.

Type locality: Washington.

Type in American Museum of Natural History.

The species has been identified from Idaho, Montana, Oregon, Wyoming, British Columbia, and Manila, Utah, June 26, 1939 (G. F. Knowlton, F. C. Harmston).

Bibiodes femorata Melander

(Plate XL, figs. 206a-b)

Bibiodes femorata Melander, 1912, Bull. Amer. Mus. Nat. Hist., vol. 31, 338.

MALE.—Shining black or brownish black with long, rather copious, gray to yellow pile; tibial spurs rufous; halteres brownish, stems slighter paler than knobs. Wings hyaline, anterior veins and stigma brown, posterior veins yellow. *Genitalia:* Ninth sternum cleft about one-third its length, gently convex in the central portion of cleft. Harpagones bilobed, with the two lobes unequal in size and shape, the smaller development is situated on the ventral portion of the harpago, is almost horizontal in position, directed inwardly and is somewhat obtuse at apex. The larger lobes are dorsal in position, almost twice the size of the ventral lobes and produced into beaklike points, on inner apices (fig. 206a). Ninth tergum but slightly wider than long, gently concave on posterior margin (fig. 206b).

Length of wing, 3.5 mm.

FEMALE.—Pile chiefly yellow, rather long on dorsum and femora. Body dark brownish to black, the specimen at hand has a distinct brownish tinge. Leg joints pale yellowish, tarsi somewhat more brown, femora distinctly swollen. Anterior veins and stigma pale brown, posterior veins concolorous with the membrane. Halteres yellowish.

This is the first female of the genus that has been observed by the author, and as far as is known none have heretofore been reported.

Type locality: Austin, Texas.

Type in American Museum of Natural History.

The writer has examined topotypic specimens, also specimens from Union City, Tenn. (G. I. Reeves).

Bibiodes halteralis Coquillett

(Plate XL, figs. 207a-b)

Bibiodes halteralis Coquillett, 1904, New North American Diptera, Proc. Ent. Soc. Wash., vol. 6, No. 3, 171.

MALE.—Head and appendages, body (with the exception of yellowed humeral ridges), coxae and femora shining black with pale yellow pile. *Legs:* Tibiae and tarsi of all legs dark rufous to reddish brown, joints darker apically; inner spurs of front tibiae very short, being about one-fifth the length of the outer; posterior tarsi not at all swollen or enlarged. Knobs of halteres yellow, their stems somewhat darker. *Wings:* Chiefly hyaline, anterior veins and stigma brown, posterior veins concolorous with the membrane. *Genitalia:* Pile yellow, more sparse than in *B. aestiva Melander.* Ninth sternum rather deeply cleft on hind margin, slightly concave at the bottom of cleft. The harpagones are strongly developed, the two lobes are very unequal in size and shape. The ventral lobe is much larger than the dorsal, is broad and rather blunt with a distinct longitudinal groove at apex; the ventral lobes are nearly horizontal in position. The dorsal lobes are more slender and acute at apices (fig. 207a). Ninth tergum much broader than long, gently concave on posterior margin (fig. 207b).

Length of wing, 3.5 mm.

Type locality: San Mateo Co., California.

Type in United State National Museum.

The species also has been reported from Los Angeles, California (Coquillett) and Claremont, California (Baker). The author has also examined specimens from Cherry Valley, California, Jan. 11, 1938 (Christenson, Clancy); Dundurn, Saskatchewan, 16-5-1923 (R. M. King), Silvery City, New Mexico, (Kellog), and Phoenix, Arizona, 4-IX-31 (E. M. Painter).

Bibionellus Edwards

Bibionellus Edwards, 1935, Stylops, Roy. Ent. Soc. of London, vol. 4, pt. I, 19.

Following is the original description of the genus and species:

"Allied to *Bibio,* differing chiefly as follows:—Wings with the costa greatly produced, reaching about half-way from R_5 to M_1 (as

in *Dilophus;* in most *Bibio* the costa ceases abruptly at tip of R_5, this being the case also in *Bibiodes*). Front tibia in both sexes with a conspicuous blunt tubercle in middle beneath (rather larger in male than in female); front femur with a slight enlargement beneath before the tip, this enlargement bearing a group of microscopic tubercles."

GENOTYPE: *Bibionellus tibialis* Edwards.

Bibionellus tibialis Edwards

Bibionellus tibialis Edwards, 1935, Stylops. vol. 4, part 1, 19-20.

"*Male.*—Head black behind and beneath. Eyes broadly in contact and constructed as usual in this family, but quite bare. Rostrum not at all produced. Antennae yellowish, very short, the flagellum composed of only 5-6 segments; palpi of moderate length, brownish. *Thorax* shining, with short and very scanty black hair; mesonotum light reddish, scutellum and postnotum blackish, pleurae dark brown. *Abdomen* shining blackish, with scanty dark hair. Hypopygium differing from the usual type of the genera *Bibio* or *Dilophus,* the styles being ventro-lateral in position, without a conspicuous emargination between them (much as in *Plecia*). *Legs* blackish-brown, including all coxae. Front tibia with a very long outer apical spine (as in *Bibio*), the inner spur very much shorter. Hind femur slender and cylindrical on basal half, much swollen on apical half; hind tibia slender on basal third but greatly swollen on apical half or more, with two moderately long and slender spurs. Hind tarsi slender, much shorter than tibia. *Wings* rather smoky, with darker stigma, all veins somewhat darker than membrane, base narrowly whitish. Base of Rs and r-m subequal in length and quite short, less than a quarter as long as R_1. M_2 and Cu_1 reaching margin. Halteres blackish.

"Wing-length 3.5-4 mm.

"Female. Differs from male in having the head, thorax, coxae, femora and tibiae wholly yellowish. Eyes quite small."

Type locality: Bolivia, Yungas von Coloico.

Type in British Museum.

Philia Meigen

Philia Meigen, 1800, Nouv. Class. Mouch., 20.

Dilophus Meigen, 1803, Illiger's Mag. 1, vol. 2, 269.

Acanthocnemis Blanchard, 1852, in C. Gay Hist. Chile Zoöl. v. 7, 355. This name was previously used by Hawle and Corda, 1848, in Crustacea and later by Signoret, 1865, in Geocoridae.

The names *Philia* and *Dilophus* have been in dispute since 1908 when Hendel pointed out that many of Meigen's 1803 genera were

the same as those described in 1800. The discussion of the status of *Dorilas* vs. *Pipunculus* will also apply to these genera. The original description of *Philia* is unmistakable and Becker had examined the Meigen types and declared the two congeneric.

The genus *Philia,* in North America, is characterized by the presence of two to three sets of strong spines on the front tibiae. The members of the genus are comparatively small and represent but slight range in size among the various species. They seldom have a wing length of over 6-6.5 mm. in our North American species. The female of several species are inseparable unless accompanied by the male and it is very desirable, and in some cases a necessity, to have both sexes present in order that an accurate identification may be made. Such species as *tingi n.* sp., *spinipes* Say, *orbata,* O. S., *stigmatera* Say, *serotina* Loew, and *arizonaensis* Hardy may be readily identified without dissection of the male genitalia, but in most other species it is essential that these structures be examined. The subcostal vein is weak and the first four radial veins are apparently fused in the anterior branch of radius, the posterior branch (R_5) is simple. The basal portion of R_5 is short compared to the r-m crossvein, being scarcely one-third its length. The posterior veins of wing are usually brownish in color while the anteriors are concolorous with the membrane. The costa extends almost half the distance from R_5 to M_1 in most species.

GENOTYPE: *Tipula febrilis* Linnaeus.

KEY TO THE SPECIES OF MALE *Philia*

1. Front tibiae each with three series of spines (fig. 219a)..... 2
   Front tibiae with only two series of spines..... 3
2. Costa extending but a short way beyond end of vein R_5; top series of tibial spines with two teeth, middle set with three teeth; entirely black species.
   tingi n. sp., p. 513
   Costa extending half the distance between tips of vein R_5 and M_1; top series with three teeth, middle set with four; dorsum of thorax chiefly rufous..*spinipes* (Say), p. 510
3. Wings dusky to black .....*serotina* (Loew), p. 509
   Wings chiefly hyaline 4
4. Rostrum (the sclerotized portion of the face below the eyes) produced nearly, or distinctly, as long as the antennae ..... 4a *stigmatera* (Say), p. 511
   Rostrum distinctly shorter than the antennae..... 5
   4a. Veins of costal margin brown; female dorsum rufous.
   stigmatera stigmatera (Say), p. 511
   Veins of costal margin and stigma almost obsolete, dorsum of female black.
   stigmatera nigra Hardy, p. 511
5. Legs chiefly yellow or pale rufous .....*arizonaensis* Hardy, p. 500
   Legs chiefly dark brown to black, coxae never yellow..... 6
6. Pile of the legs and body dark, harpagones each with a broad inner, lateral development (fig. 212a) .....*orbata* (Osten Sacken), p. 507
   Pile of the legs and body pale..... 7
7. Posterior margin of ninth tergum straight or nearly so..... 8
   Posterior margin of ninth tergum decidedly concave or emarginate..... 11
8. Harpagones broadly flat-topped from lateral view (fig. 211b), *oklahomensis* Hardy, p. 506
   Harpagones not as above 9

9. Ninth tergum about as long on median line as across hind margin (fig. 208d), cleft of ninth sternum about one-third the length of the segment; stigma obsolete.
9a *breviceps* (Loew), p. 501
Ninth tergum distinctly broader than long 10
9a. Dorsum of female thorax yellow to rufous ..... *breviceps breviceps* (Loew), p. 501
Dorsum of female chiefly black, only humeri rufous, *breviceps atelestes* Hardy, p. 502
10. Cleft of ninth sternum broad and shallow, not over one-fourth the length of the segment; ninth tergum not much wider than long; stigma faint or obsolete.
tibialis (Loew), p. 512
Cleft of ninth sternum about half the length of the segment; ninth tergum conspicuously wider than long, three to four times as wide; stigma distinct.
proxima (McAtee), p. 508
11. Cleft of sternum less than one-third the length of the segment; harpagones not greatly thickened apically; thorax of female chiefly rufous 12
Cleft of sternum at least one-third the length of the segment; harpagones usually conspicuously thickened apically, narrowed basally 13
12. Cleft of sternum about one-fourth the length of the segment; harpagones appearing sharply pointed from ventral view, broadly flat-topped from lateral view (some atypical specimens may run here) ..... *oklahomensis* Hardy, p. 506
Cleft of sternum usually about one-third the length of the segment; harpagones with rather distinct beaklike apices, not square-topped from lateral view.
strigilata (McAtee), p. 512
13. Cleft of sternum reaching nearly to the base of segment ..... *secta* (McAtee), p. 508
Cleft not over one-half the length of the segment 14
14. Ninth tergum conspicuously angulate emarginate, (fig. 210a), *emarginata* (McAtee), p. 503
Ninth tergum gently to decidedly concave, not with a V-shaped cleft 15
15. Ninth tergum not much wider than long, cleft of ninth sternum sometimes expanding at the bottom 16
Ninth tergum about two times as wide as long, posterior veins and stigma concolorous with membrane or nearly so ..... *obesula* (Loew), p. 505
16. Stigma present, cleft of ninth sternum usually expanding basally (fig. 209a), apex of each harpago with a nitch beneath; tergum gently concave on hind margin.
caurina (McAtee), p. 502
Stigma obsolete, cleft of sternum narrowed basally, usually expanding at the top; tergum more distinctly concave ..... *jamesi* Hardy, p. 504

KEY TO THE FEMALE *Philia*

1. Front tibiae with three series of spines (fig. 219a) 2
Front tibiae with only two series of spines 3
2. Costa extending but a short distance beyond end of vein R_5; top series of tibial spines with two teeth, middle set with three; thorax black ..... *tingi* n. sp., p. 513
Costa extending half way between tips of veins R_5 and M_1; top series with three teeth, middle set with four; thorax entirely rufous ..... *spinipes* (Say), p. 510
3. Wings dark 4
Wings chiefly hyaline 5
4. Thorax, coxae, and femora rufous ..... *serotina* (Loew), p. 509
Thorax black, legs dark reddish brown to black ..... *orbata* (Osten Sacken), p. 507
5. Rostrum (sclerotized portion of the face below eyes) produced, nearly or distinctly as long as the antennae ..... 5a *stigmatera* (Say), p. 511
Rostrum not produced, distinctly shorter than the antennae 6
5a. Dorsum of thorax rufous ..... *stigmatera stigmatera* (Say), p. 511
Dorsum of thorax chiefly black ..... *stigmatera nigra* Hardy, p. 511
6. Thorax chiefly rufous above 7
Thorax chiefly black, never more than humeri rufous 10
7. All tibiae yellow, concolorous with femora ..... *arizonaensis* Hardy, p. 500
All tibiae dark reddish to brown, darker than femora 8
8. Teeth of prothoracic comb broad and blunt, comb comprised of seven to ten teeth; v comb very prominent, higher than the eye height ..... *strigilata* (McAtee), p. 512
Teeth of comb not so well developed and more numerous, smaller and more acute, usually twelve to sixteen teeth, (rarely 9-10); comb not so prominent 9

9. Pleurae entirely rufous or yellow, middle comb of front tibiae with large broad teeth ..... *oklahomensis* Hardy, p. 506
Pleurae usually with dark markings, teeth of middle comb not so well developed. *breviceps* (Loew), p. 501
10. Legs entirely black except for yellowish front coxae..... *fulvicoxa* (Walker), p. 503
More of legs yellow to rufous..... 11
11. Middle and hind femora dark ..... *emarginata* (McAtee), p. 503
All femora pale 12
12. Middle and hind tibiae and tarsi pale..... *proxima* (McAtee), p. 503
Middle and hind tibiae and tarsi dark..... 13
13. Humeri dark brown to black..... *jamesi* Hardy, p. 504
Humeri rufous....*obesula* (Loew), *secta* (McAtee), *tibialis* (Loew), *caurina* (McAtee), *breviceps atelestes* Hardy

Philia arizonaensis Hardy

Philia arizonaensis Hardy, 1937, Proc. Utah Acad. Sci. Vol. XIV, 209-210.

Following is the original description:

"*Male.*—The male of this species is very distinctive in having the coxae, trochanters, femora and tibiae (except reddish brown front tibiae) pale yellow to rufous; tarsi brown. Eyes light brown with very short, sparse, dark pile, face with yellow-gray pile. First two segments of antennae, basal joints of palpi, and oral margin yellowish, other segments of antennae and palpi brown to black. Dorsum of thorax chiefly black, humeral ridges and posterior margin of dorsum tinged with yellow; pleurae dark with rufous markings; abdomen fuscous. Knobs of halteres dark yellow, stems pale. Wings slightly yellow fumose, costal cell deeply yellow fumose; anterior veins brown, stigma yellow brown, posterior veins but slightly yellowed. *Male Genitalia:* Genital cleft (ninth sternum) shallow, not over one-fifth to one-fourth the length of the segment. Stylus (clasper) rather narrow, not broadly tipped. Superior plate (ninth tergum) gently concave on the posterior margin, slightly wider than long. Pile of genitalia sparse and yellow.

"*Female.*—The female differs in having the thorax entirely yellow to rufous, abdomen lighter, reddish brown and the wings more yellow fumose.

"Length of wing, 3-4 mm."

Type locality: Huachuca Mts., Arizona.

Type in United States National Museum.

The writer has seen additional specimens from the type locality, Aug. 18, 1938 (R. H. Beamer) also from Tajique, New Mexico, June 25, 1940 (R. H. Beamer, D. E. Hardy) and Austin, Nev., Aug. 12, 1940 (D. E. Hardy).

Philia breviceps (Loew)

(Plate XL, figs. 208a-d)

Dilophus breviceps Loew, 1859, Dipt. Amer. Sept. indig., Cent. 9, No. 50, Compl. Works, vol. 2, p. 200.

Dilophus occipitalis Coquillett, 1904, Invert. Pacifica I, 20.

D. occipitalis is based upon the female sex. The writer has examined the type at the United States National Museum and it appears to be the same as *breviceps* Loew.

MALE.—Shining black, legs sometimes with a brownish tinge. Pile of eyes very short and dark, that of face longer, gray; thorax almost devoid of pile, except for two rows of dorso-central hairs; pile of coxae and femora long, yellow, that of tarsi and tibiae yellow to gray. Anterior thoracic comb usually with twelve to fourteen acutely pointed teeth. Knobs of halteres fuscous, stems paler. Wings hyaline, anterior veins yellow to yellow-brown, stigma usually obsolete, posterior veins entirely concolorous with the membrane. *Genitalia:* Ninth sternum moderately narrow, not broadly expanded; genital cleft about one-third the length of the segment and narrowing slightly basally (fig. 208a). Harpagones somewhat thickened apically, bluntly pointed and rather flat topped from lateral view (fig. 208c). Ninth tergum about as long as wide on median line, anterior margin but gently concave, almost straight (fig. 208d). Pile of the genitalia sparse and pale.

FEMALE.—Pile yellow; head black; dorsum of thorax (except area of thoracic combs), anterior coxae and all femora yellow to rufous. Middle and hind coxae, tibiae and tarsi dark rufous to brown; pleurae with brown to black markings; abdomen deep brown to sordid yellow; the sterna being slightly lighter than the terga. Prothoracic comb with twelve to eighteen teeth, shorter than the eye height; knobs of halteres fuscous, stems pale. Wings yellow fumose, anterior veins and large stigma yellow-brown to dark brown; posterior veins slightly darker than the membrane.

Length of wing, 3.5-4.5 mm.

Type locality: New Hampshire.

Type in Cambridge Museum of Comparative Zoölogy.

The species has been identified from Alabama, Illinois, Louisiana, Mississippi, North Carolina, Ohio, Oregon, Quebec and Wisconsin. It has also been reported from Ontario and New York.

Philia breviceps var. *atelestes* Hardy

Philia breviceps var. *atelestes* Hardy, 1937, Proc. Utah Acad. Sci., vol. XIV, 210.

The females of this variety have the dorsum of thorax entirely black except for the rufous humeri, the abdomen is dark brown to black. Legs and pleurae of the males are for the most part lighter in color than typical *breviceps*, usually being distinctly reddish in ground color.

Type locality: Meach Lake, Quebec.

Philia caurina (McAtee)

(Plate XL, figs. 209a-c)

Dilophus caurinus McAtee, 1921, Notes on Nearctic Bibionid Flies, Proc. U. S. Nat. Mus. vol. 60, p. 19.

The following is the original description:

"*Male.*—Entirely shining or subshining black, eyes with copious long dark hair, hair of other parts of body and of coxae and femora long, pale; of tibiae and tarsi shorter, more bristly, tending to be darker especially on tarsi; genital segments cleft about half its length, the cleft often distinctly expanded at bottom, superior plate only about three times as long as wide along hind margin which is slightly concave; wing grayish hyaline, veins near costa and large stigma pale brown.

"*Female.*—Head and thorax black, abdomen brown, with pale hairs; humeri, front (sometimes all) coxae, and femora yellow to rufous with pale hair, tibiae and tarsi brownish to black, color of hair corresponding to depth of coloring of joints; halteres with pale stalks and dark knobs; wings clear to yellowish hyaline, sometimes with transverse dusky clouding at level of stigma, veins near costa and stigma brownish, others nearly hyaline.

"Length of wing, 4.5-6 mm."

Upon dissecting the genitalia from a paratype male of *caurina* the writer finds that McAtee has misinterpreted the width and length of the ninth tergum as well as the depth of the cleft of ninth sternum. The following corrections and additions should be made to his description: Cleft of ninth sternum (genital cleft) slightly over one-third the length of the segment, cleft expanding basally, narrowed apically (fig. 209a). Harpagones with well developed heads, narrowing basally; apices of claspers thickened, apical portions pointed underneath, and with a ridge or tooth under the point (fig. 209b). Ninth tergum (superior plate) slightly wider than long, posterior margin gently concave (fig. 209c).

Type locality: Popoff Island, Alaska.

The author has examined the type series at the United States National Museum.

It is very common and widely distributed, especially throughout northern United States and Canada. Specimens have been examined from British Columbia, Michigan, New Mexico, Ohio, Utah and Washington.

Philia emarginata (McAtee)

(Plate XL, figs. 210a-b)

Dilophus emarginatus McAtee, 1921, Proc. U. S. Nat. Mus., 60, 20.

Following is the original description with added notes on the male genitalia:

"*Male.*—Body shining black, legs more brownish, the front tibiae darker; close-set hair of eyes dark, longer hair of underside of head, body and greater part of legs pale, of front tibiae and tarsi dark; genital segment with a cleft half its length, rounded expanded at the bottom, superior plate decidedly not transverse, about as long as wide across hind margin which is distinctly angularly emarginate; wings hyaline, veins near costa brown, stigma nearly obsolete.

"*Female.*—Humeri obscurely castaneous, thorax otherwise, and head shining black, abdomen velvety brownish black; legs rufous more or less suffused with brown, the front coxae and femora palest; all hairs pale; wings hyaline, veins near costa distinct, stigma brown.

"Length of wing, 4.5 mm."

The cleft of ninth sternum does not extend quite half the length of the segment (fig. 210b) and the bottom of the cleft is slightly convex. Harpagones simple, slightly enlarged apically and each with a small indentation just below apex. The cleft of ninth tergum (superior plate) extends about one-fourth the length of the plate (fig. 210a).

Type locality: Samoa, California.

The author has examined the type and allotype at the United States National Museum, also one male topotype specimen, same data and in the same collection as the type. This was evidently overlooked by the author of the species.

Philia fulvicoxa (Walker)

Dilophus fulvicoxa Walker, 1848, List of Dipt. Brit. Mus. I, 117.

The writer does not know this species. It is based upon a female specimen which appears to be distinctive in having the legs chiefly black. The following is the original description:

"Niger, thoracis dorso serrato, coxis anticis fulvis, alis limpidis, fusco unimaculatis.

"Body black, shining; eyes red: feelers black: a toothed ridge along the chest: abdomen dull black: legs black; fore hips tawny: wings colourless; a large, irregular, light brown spot under the brand, which is dark brown; fore border veins piceous; the other veins tawny; poisers piceous. Length of the body 2 lines; of the wings 5 lines."

Type locality: St. Martins Falls, Albany River, Hudson's Bay.

Type in British Museum.

Philia jamesi Hardy

Philia jamesi Hardy, 1937, Proc. Utah Acad. Sci. XIV, 210-211.

Species somewhat related to *tibialis* (Loew) but is distinguished by the concave posterior margin of the ninth tergum and the more deeply cleft ninth sternum. Following is the original description:

"*Male.*— Male shining black; eyes with dark hair, that of face yellow-gray; pile of dorsum dark gray to brown (sometimes chiefly yellow), that of pleurae, abdomen, coxae and femora yellow to reddish, of tibiae and tarsi yellow to brown. Knobs of halteres black, stems yellowish. Wings hyaline, anterior veins yellow to yellow-brown, stigma and posterior veins concolorous with the membrane, obsolete. *Male Genitalia:* Superior plate (ninth tergum) rather deeply and evenly convex, cerci rather large and chiefly membranous. Tenth tergite represented by a small slightly chitinized area on the membrane. Genitalia for the most part light haired (some darker hair on the 9th sternite) and with fine yellowish pubescence. The inner edges of the genital cleft being densely yellowish white pubescence. Genital cleft (ninth sternum) slightly convex centrally, and narrowed basally, usually expanded at the top. Coxite rounding apically with dense, fine, pale hair on the inner edges and longer and darker hair on the apices. Stylus (harpago) pointed, point appearing somewhat flattened on the dorsal view of the genitalia.

"*Female.*—The female differs in having the coxae, and femora rufous and tibiae and tarsi brownish red; humeri dark reddish-brown to black. Abdomen fuscus to black; wings slightly yellowish, anterior veins and stigma dark brown, posteriors concolorous with the membrane.

"Length of wing, 4-5 mm."

Type locality: Masonville, Colorado.

Type returned to Colorado State College.

Added distribution: LaSal, Utah, 7-24-40 (G. F. Knowlton, F. C. Harmston); Rondeau Prov. Pk., Kent. Co., Ontario, June 8, 1935 (Steyskal); and Livingston Co., Mich. Hamburg, Aug. 12, 1934 (Geo. Steyskal).

Philia obesula (Loew)

Dilophus obesulus Loew, 1869, Dipt. Amer. Sept. indig., Cent. 9, No. 60, Compl. Work, vol. 2, p. 200.

The following is the description given by McAtee:

"*Male.*—Lower surface of head black with long pale hair, eyes with shorter more abundant dark hair, thorax and abdomen shining black with long, sparse, pale hair; genital segment with a U-shaped cleft about half its length, superior plate transverse, about four times as broad as long, its hind margin slightly concave; legs reddish brown to black, in general pale haired but hairs on tibiae and tarsi (especially the front ones) often in part or wholly dark; wings and veins nearly hyaline, slightly fumose costally, stigma almost obsolete.

"*Female.*—Head black with short pale hair; humeri rufous, thorax elsewhere above shining black with sparse pale hair; pleura brownish-black more or less spotted with paler; abdomen velvety brownish black with abundant pale hair; coxae and femora (and sometimes the front tibiae) yellow to rufous, pale haired; trochanters, tibiae darker haired; wings nearly hyaline, veins near costa brown, rather large stigma nearly black. Females from western localities usually have more or less dusky clouding transversely in the wing at the level of the stigma.

"Length of wing, 4-5 mm.

Upon dissecting the genitalia of specimens identified as *obesula* Loew by McAtee and a large series recognized as this species by the writer it has been found that the length of the ninth tergum (superior plate) has been misinterpreted by the previous workers. This is very easily done because of the normal position of the eighth tergum which usually partially covers the dorsal portion of the ninth. If the genitalia are unrelaxed the true relationship of these segments cannot be determined. The ninth tergum is but slightly over two times as wide as long, instead of four times.

Type locality: District of Columbia.

Type in Cambridge Museum of Comparative Zoölogy.

This is a widely distributed species, McAtee reports it from Maryland, Virginia, Pennsylvania, North Dakota, Colorado, Indiana and

Idaho. The writer adds the following states and provinces: California, Manitoba, Quebec, British Columbia, Ontario and Michigan.

Philia oklahomensis Hardy

(Plate XL, figs. 211a-d)

Philia oklahomensis Hardy, 1937, Proc. Utah Acad. Sci. XIV, 211.

This species is distinguished by the shallow cleft on posterior margin of ninth sternum, the broad flat-topped harpagones of male (fig. 211b) and the entirely rufous thorax and strong development of thoracic combs of the female. Following is the original description:

"*Male.*—Chiefly shining black; humeral ridges yellowed, legs with rufous tinge; stems of halteres yellow, knobs brown. Pile of body short and yellow, that of legs somewhat reddish. Wings (fig. 211c) hyaline, slightly yellow fumose costally; anterior veins brown, stigma pale, usually obsolete; posterior veins concolorous with the membrane. *Male Genitalia:* Coxite comparatively short and broad with a raised area longitudinally down the middle of the pons coxalis; genital cleft (cleft of ninth sternum) rather shallow, being about one- fourth the length of the segment (fig. 211a). Stylus (harpago) appearing pointed from ventral or dorsal view. Posterior margin of superior plate (ninth tergum) gently concave, sometimes appearing straight because of the tenth tergite beneath; (reëxamination shows that the hind margin of ninth tergum is straight, a lighter median area was first interpreted as a concavity); plate slightly wider than long. Cerci larger, pointed apically (fig. 211d). Pile of genitalia short and yellow.

"*Female.*—Differs in having the entire thorax, coxae, trochanters and femora yellow to rufous; tibiae and tarsi dark reddish to brown, and wing yellow fumose.

"Length of wing, 4-4.5 mm."

Type locality: Locust Grove, Oklahoma.

Type returned to Oklahoma A. & M. College.

This species is common in Oklahoma and Texas during March and early April. No fall specimens have been seen so it might have just one generation.

Philia orbata (Osten Sacken)

(Plate XLI, figs. 212a-c)

D. (ilophus) orbatus Osten Sacken, 1859, in Le Conte's edition of The Complete Writings of Thomas Say on the Entomology of North America, vol. 2, p. 70.

This species is related to *stygius* Say, but is readily distinguished from this Mexican species by its much smaller size, shorter rostrum and different arrangement of the median set of teeth on front tibiae.

MALE.—Head, body and legs shining, brownish to black. Pile entirely black, that of hind femora sometimes gray. Compound eyes divided into an upper and lower portion by a transverse indentation near lower margins. Rostrum produced but little over half the length of antennae. Antennae short, segments compacted, eleven segmented with a knoblike tip. Knobs of halteres brown, stems ochraceous. Wings slightly yellowish hyaline, more distinctly yellow costally; anterior veins yellow-brown, stigma dark brown; posterior veins but slightly more yellowed than the membrane, almost concolorous. Front tibiae armed with two sets of teeth, the median set possesses four strong spines in a transverse row. *Genitalia:* Pile of genitalia black, rather dense along the posterior margin of the ninth tergum. Cleft of ninth sternum extends about one-third the length of segment, the middle of the cleft is slightly convex. The harpagones each have a broad inner lateral development (fig. 212a), which is characteristic of the species. The ninth tergum is gently concave and very short, three to four times as wide as long. The cerci are well developed and usually extended. The tenth segment (anal region) is slightly sclerotized on the margins (fig. 212b).

FEMALE.—The female differs in having the wings yellow-brown fumose to dusky black; anterior veins and stigma dark brown, posteriors darker than the membrane. The rostrum is about equal to the length of compound eyes.

Length: body, 3.5-3.8 mm.; wings, 4-4.2 mm.

Type locality: Florida.

Present location of type is unknown.

This species is widely distributed throughout Southeast and Central United States, specimens have been examined from numerous localities in the following states: Alabama, Florida, Georgia, Kansas, Louisiana, Mississippi, North Carolina, Oklahoma (on cotton in Payne Co.), South Carolina and Texas.

Philia proxima (McAtee)

(Plate XLI, figs. 213a-c)

Dilophus proximus McAtee, 1921, Proc. U. S. Nat. Mus. 60, Art. II, 22.

MALE.—Head, body and legs shining black, sometimes faintly reddish black in ground color. Pile of body yellowish, eyes with short brown to black pile. Lower one-third of compound eyes separated off by a transverse groove across the eye. Wings hyaline to somewhat milky, anterior veins and stigma brown, posteriors concolorous with the membrane. *Genitalia:* Ninth sternum cleft almost half its length on hind margin, the cleft is slightly convex in the middle (fig. 213a). Harpagones broad and rounded, with a distinct indentation on under sides near apices (fig. 213c) and a longitudinal groove on upper edges. Ninth tergum about three times as wide as long (not four times as in original description), hind margin straight or but very gently concave with the anterior margin somewhat convex (fig. 213b).

Following is the original description of females:

"*Female.*—Head and thorax except humeri shining black, and abdomen velvety brown, all with short pale hair; humeri and legs chiefly yellow to rufous, tibiae and tarsi, especially of the front legs deeper colored, sometimes black; in pale specimens the trochanters, distal tarsal joints and apices of other tarsal joints only are black, hair of legs except tarsi pale; wings hyaline, veins near costa and stigma brown.

"Length of wing, 3-5 mm."

Upon dissection of a paratype male of this species it was found that the cleft of ninth sternum (genital cleft) is but slightly over one-third the length of the segment. The harpagones are rather distinctive, having a developed beak at apices.

McAtee reports the species from Colorado, and Hunters Creek, Wyoming. The author has studied the type at the United States National Museum and has seen topotype specimens from Hunters Creek, also specimens from Two-gwo-to-ee Pass, Wyoming, IX-12-95 (W. M. Wheeler).

Philia secta (McAtee)

Dilophus sectus McAtee, 1921, Proc. U. S. Nat. Mus. vol. 60, Art. 11, p. 22.

The original description is given:

"*Male.*—Body shining black, legs brownish black; eyes with short, close-set, dark hair; body and legs with longer, sparse pale hair, except on tarsi where it is chiefly dark; genital segment cleft nearly

to its base, superior plate about three times as wide as long, distinctly concave posteriorly; wings hyaline, veins near costa and nearly obsolete stigma yellowish brown.

"*Female.*—Head shining black, with a few short pale hairs; thorax chiefly shining black, with short, sparse pale hairs, humeri yellowish-rufous and indistinct patches on pleura and scutellum yellowish brown; abdomen velvety brownish-black, with pale hairs; coxae and femora yellowish rufous; trochanters, tibiae and tarsi fuscous to black, those of anterior legs darkest; hair of legs chiefly pale except on tarsi; wings as in male, stigma somewhat more distinct.

"Length of wing, 4.5-5.5 mm."

McAtee reports it from Franconia, New Hampshire, and from White Mts. (Morrison). The author has examined the type at the United States National Museum.

Philia serotina (Loew)

(Plate XLI, figs. 214a-b)

Dilophus serotinus Loew, 1861, Dipt. Amer. Sept., Cent. 1, No. 15, Compl. Work, 9-10.

This species is easily recognized by its dusky to black fumose wings and large size.

MALE.—Chiefly shining black. Pile of eyes black, that of face gray, of thorax, coxae, trochanters, femora and posterior half of abdomen yellow to gray; pile of tibiae and tarsi black. Knobs of halteres black, stalks pale. Wings dusky to blackish, darker costally, anterior veins black, posteriors gray. *Genitalia:* Pile of genitalia dense, brownish yellow. Cleft of ninth sternum extending slightly over one-third its length. Inner edges (when viewed from a ventral aspect) of apical portion of ninth sternum with a developed process. Harpagones with a strongly produced beaklike apex (fig. 214a). Ninth tergum gently concave, about as wide as long (fig. 214b).

FEMALE.—The female has the thorax (except black scutellum and some black markings on the pronotum), coxae, trochanters and femora rufous, hind coxae somewhat darker than front. Pile all pale. Wings usually somewhat darker; otherwise like male.

Length of wing, 4.5-8.5 mm.

Type locality: Illinois.

Type in Cambridge Museum of Comparative Zoölogy.

This species has a rather wide range; the writer has examined the type, also material from British Columbia, Kansas, Louisiana, Maryland, Missouri, Oregon, Virginia and Washington. It has also been recorded from Mississippi.

Philia spinipes (Say)

(Plate XLI, figs. 215a-b)

D. (ilophus) spinipes Say, 1823, Dis. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3, 79-80. 1859 Compl. Writings, vol. 2, p. 71.

D. (ilophus) thoracicus Say, 1823, Des. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3, p. 80. 1859 Compl. Writings, vol. 2, pp. 71-72.

Dilophus dimidistus Loew, 1869, Dipt. Amer. Sept. indig., Cent. 8, No. 3, Compl. Work, vol. 2, p. 118.

McAtee states that the variation in size and color of this species sufficiently covers the other two forms which were described having three series of spines on the front tibiae; the types have not been studied so this cannot be verified.

MALE.—Rostrum long, about one-half to three fourths as long as the antennae, extended proboscis longer than the antennae. Lower part of compound eyes and face black, upper part reddish brown. Dorsum of thorax chiefly bright rufous, scutellum and pronotum usually black; pleurae reddish brown with black markings. *Legs:* Front tibiae with three sets of spines, top set with three spines, middle set with four, apical set with eleven or twelve (fig. 215a). Apical spur slightly longer than the spines at apex. Front and middle coxae and femora rufous, remainder of legs brown to black; abdomen velvety black. Pile chiefly black, somewhat gray on the femora. Knobs of halteres black, stem paler. Wings dusky to yellow-brown fumose, darker costally; anterior veins dark brown, posteriors and stigma light brown. *Genitalia.*—Pile of genitalia brown to black. Cleft of ninth sternum extends about one-third the length of the segment (fig. 215b). Harpagones pointed apically, broadened at their bases. Cerci large and rounding. In the specimen dissected the ninth tergum had been torn, McAtee states that this plate is about three times as wide as long with hind margin rounded angulate.

FEMALE.—The female has the thorax entirely rufous (sometimes with a few dark markings on the pronotum and scutellum), the rostrum is in part yellow to rufous and the abdomen velvety brown; otherwise like the male.

Length of wing, 4.5-6 mm.

Type locality: Missouri.

Location of type not known to this writer.

Specimens have been examined from a number of localities in the following states: California, Florida, Indiana, Louisiana, Maryland, Minnesota, Mississippi, Missouri, New Jersey, New York,

North Carolina, Tennessee, and Virginia; also reported from New England.

Philia stigmatera (Say)

(Plate XLI, figs. 216a-b)

D. (ilophus) stigmaterus Say, 1823, Desc. Dipt. U. S., Journ. Acad. Nat. Sci. Phil., vol. 3, pp. 79-80. 1859 Compl. Writings, vol. 2, pp. 70-71.

The species is readily distinguished by the elongate rostrum which is about as long as the antennae; *spinipes* (Say) and *tingi* n. sp. also have the rostrum developed but these species have three series of spines on the front tibiae.

MALE.—Eyes reddish brown with short dark pile; remainder of head and body shining black, with yellow pile; body sometimes with a tinge of rufous. The legs vary from dark rufous to brownish black with rather abundant yellow to reddish hair. Wings hyaline, anterior veins yellow-brown, posteriors concolorous with the membrane; stigma small and almost obsolete. Knobs of halteres dark, stems pale. *Genitalia:* Ninth sternum cleft about one-third its length, harpagones simple and obtuse at apices (fig. 216a). Ninth tergum wider than long, hind margin gently concave (fig. 216b).

FEMALE.—The female differs in having the thorax and legs chiefly yellow to rufous, pronotum, scutellum and pleurae sometimes with dark markings; spines of front tibiae and tips of tarsal joints brown. Abdomen velvety brown, genitalia more or less tipped with yellow. Wings more yellowish fumose, stigma distinct brown.

Length of wing, 3.5-5 mm.

Type locality: Missouri.

Location of type unknown to the writer.

Specimens have been examined from Alberta, Arizona, British Columbia, Colorado, Indiana, Iowa, Michigan, New Mexico, Nova Scotia, Quebec, South Dakota, Utah and Wisconsin.

Philia stigmatera nigra Hardy

Philia stigmaterus var. *nigra* Hardy, 1937, Proc. Utah Acad. Sci. vol. XIV, p. 212.

The females have the dorsum of thorax, except the humeri, chiefly shining black instead of rufous as in the typical *stigmatera*. The anterior veins of the wings of the males are more consistently lighter in color in *nigra*. This is probably best considered a subspecies.

Type locality: Polk Co., Minnesota.

Type in University of Minnesota collection.

Added distribution: The Pas, Manitoba, Aug. 11, 1937 (R. H. Daggy) and Gillam, Manitoba, Aug. 10, 1937 (D. G. Denning).

Philia strigilata (McAtee)

(Plate XLI, figs. 217a-b)

Dilophus strigilatus McAtee, 1921, Proc. U. S. Nat. Mus. vol. 60, Art. 11, pp. 24-25.

The males of this species are somewhat related to *oklahomensis* Hardy but the cleft of ninth sternum is deeper and the harpagones acutely pointed.

MALE.—Shining black (except reddish brown compound eyes), legs sometimes brownish. Pile pale yellow except for the short black pile on the eyes. Knobs of halteres black, stems pale. Wings hyaline, costal cell slightly yellowed; anterior veins concolorous with the membrane. *Genitalia:* Cleft of ninth sternum extends about one third the length of the segment. Harpagones rather thickened but not greatly enlarged apically, terminating in a beak (fig. 217b). Ninth tergum about twice as wide as long on a median line (fig. 217a).

FEMALE.—The female is similar to *breviceps* Loew but differs in having the prothoracic comb more conspicuously developed. The teeth are fewer in number (usually 7-10), longer, more broad and blunt. The female differs from the male in having the thorax, coxae and femora chiefly rufous; pronotum and thoracic comb, pleurae and hind coxae usually marked with black. Wings yellowish to dusky fumose, anterior veins and large stigma dark brown, posteriors slightly more yellowed than membrane.

Length of wing, 4.5-5 mm.

Type locality: California.

Type in the United States National Museum.

The species is common in California and has been identified from numerous localities in that state.

Philia tibialis (Loew)

(Plate XLI, figs. 218a-c)

Dilophus tibialis Loew, 1869, Dipt. Amer. Sept. indig., Cent. 9, No. 61, Compl. Work, vol. 2, p. 200.

This species is recognized by the shallow cleft of ninth segment, the straight hind margin of ninth tergum and the almost obsolete stigma and paler anterior veins.

MALE.—Head and body shining, legs brownish red to black. Pile rather long and chiefly pale, that of eyes, tibiae and tarsi somewhat darker. Wings hyaline, slightly fumose costally; anterior veins brown, stigma almost obsolete; posterior veins concolorous with the membrane. *Genitalia:* Ninth sternum broad, cleft extending less

than a third the length of the segment. Harpagones rounded apically (fig. 218a). Ninth tergum wider than long, the posterior edge straight or nearly so (fig. 218b). Pile of genitalia pale and very short.

FEMALE.—Female differs in having the humeri, pleurae (in part), coxae and all femora yellow to rufous; middle and hind coxae and all tibiae and tarsi brownish to black. Wings slightly yellowed, stigma distinct.

Length of wing, 4.5-6.5 mm.

Type locality: Sitka, Alaska.

Type in Cambridge Museum of Comparative Zoölogy.

This species is very abundant in the North. Specimens have been examined from numerous localities in the following possessions, states and provinces: Alaska, Alberta, British Columbia, California, Idaho, Manitoba, Michigan, Minnesota, Montana, Ontario, Oregon, Quebec, South Dakota, Utah, Washington and Wisconsin.

Philia tingi n. sp.

(Plate XLI, fig. 219a)

This species is related to *spinipes* (Say) by having three series of toothlike spines on each of the front tibiae. It is readily distinguished by the short costa, the black coloration, the blunt, rounding teeth of thoracic combs, its much smaller size and the shorter head length of the females.

FEMALE.—*Head:* Entirely shining black, rather thickly black haired. The rostrum is produced longer than the antennae and the extended mouthparts reach almost three times the antennal length. Antennae short, the segments compacted, apparently eleven segmented. The segments of the flagellum are so compressed that it is difficult to discern their articulations. The rostrum is shorter than the antennae in *spinipes* and the mouthparts are not so elongated. The compound eyes are longer than the length of head behind the eyes, eyes of *spinipes* much shorter, more rounded. *Thorax:* Shining black, except the faintly reddish thoracic combs. Teeth of thoracic combs short and blunt, anterior comb composed of ten to twelve teeth, comb scarcely divided in the middle. Dorsocentral and marginal hairs long and thin, mesopleurae and sternopleurae with scattered long marginal pile; all thoracic pile yellowish. *Legs:* Largely black, only the front tibiae rufous; front femora and coxae faintly reddish tinged in the median portions; all tibiae and metatarsi with a very faint rufous cast in the black ground color. Front

tibiae with three series of spines (fig. 219a), the top set is situated on the upper third of the segment and contains just two teeth; the middle set is at about the median portion and has three teeth; the third or apical set is made up of eight spines counting the apical spur. All tibial spines are rather broad and blunt, the apical spur is shining black and much larger than the spines at the ends of the tibiae. *Philia spinipes* (Say) has three teeth in the top set and four in the median, the spines are more acute and the apical set contains eleven or twelve teeth. *Wings:* Entirely hyaline, anterior veins and stigma brown, posteriors concolorous with the membrane. The costa extends but a short distance beyond the tip of vein R_5 (posterior branch of radius), about one-fifth the distance between tips of R_5 and M_1; the costa of *spinipes* half the distance between these veins. The abdomen is blackish brown, the sclerites and conjunctiva of the venter are faintly tinged with yellowish. Cerci black, covered with thick yellow pile.

Length: body and wings, 3.4-3.5 mm.

MALE.—Compound eyes sparsely brown to black haired, lower one-third to one-fourth of each eye is divided off by a transverse depressed area. Rostrum longer than antennae and covered with dense black hair and mouthparts produced as in female. Body and legs entirely black.

Length: body and wings, 3-3.1 mm.

Holotype female, Cronise Lk., San B. Co., Calif., April 28, 1937, No. 300 (P. C. Ting). Allotype male and two paratype females, same data as type. These specimens were collected on the blossoms of Prosopis.

The writer takes pleasure in naming this species after Mr. P. C. Ting, State of California, Department of Agriculture, who has contributed much valuable information concerning the immature stages of Bibionidae.

Holotype and allotype returned to Mr. Ting, paratypes in Snow Entomological Collection.

The following species are unidentifiable from the original descriptions:

Philia longiceps (Loew), 1861, Dipt. Amer. Sept. indig., Cent. 1, 14, Compl. Work, p. 9. Described from Illinois. This might possibly be *breviceps* (Loew).

Philia pusillus (Wiedemann), 1828, Ausz. Zweifl. Ins. vol. I, 77. (United States?).

Philia serraticollis Walker, 1848, List Dipt. Brit. Mus., pt. I, 117. Described from St. Martin Falls, Albany River, Hudson Bay.

Plecia bimaculata Walker, 1856, Insecta Saunder. I, 422. United States given as type locality. McAtee states that this may be a Philia.

ACKNOWLEDGMENTS*

The writer wishes to express his sincere appreciation for the invaluable assistance given by Doctors H. B. Hungerford and R. H. Beamer at the University of Kansas and the able direction and stimulation of Doctors G. F. Knowlton of the Utah State Agricultural College and V. M. Tanner of the Brigham Young University. It was under Doctor Knowlton's supervision that the study of Dorilaidae first began in earnest and the interest he has always shown in this work has been a constant inspiration. For any degree of completeness attained by this study the writer is indebted to the assistance and enthusiasm of Doctor Beamer. The biological surveys of the summers of 1939 and 1940, under his direction, produced a wealth of material and much valuable field data, without which this paper would have been very incomplete. Gratitude is expressed for the kind coöperation given the writer during his recent trip through the east studying the types by Messers. C. F. W. Muesebeck, D. G. Hall, P. W. Oman, C. T. Greene and Dr. Alan Stone of the United States National Museum; Mr. E. T. Cresson of the Philadelphia Academy of Sciences; Dr. C. H. Curran, American Museum of Natural History; Mr. N. Banks, Cambridge Museum; Dr. Richard Dow, Boston Society of Natural History, and Doctors W. J. Gerhard and E. Liljeblad, Field Museum in Chicago.

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The data presented in this paper have been gathered from the examination of more than thirty thousand specimens supplied by the major collections of the United States and Canada, by many of the European museums, and by a number of collectors in South and Central America. The author is indebted to all who have contributed to this study by the loan of material. Coöperation has been general, but special gratitude must be expressed to the United States National Museum, the American Museum of Natural History, the Philadelphia Academy of Sciences, the Cambridge Museum of Natural History, and the Boston Society of Natural History. Specimens have also been received from: Utah State Agricultural College; Brigham Young University; Canadian Museum; Dr. M. T. James, Colorado State Agricultural College; Doctors J. C. Bradley, P. P. Babiy and Mr. L. L. Pechuman, Cornell University; Mr. J. Wilcox, Alhambra, California; Dr. C. L. Fluke, University of Wisconsin; Professor H. E. Jaques, Iowa Wesleyan College; Professor F. A. Urquhart, Royal Ontario Museum of Zoölogy; Dr. S. W. Bromley, Stamford, Connecticut; Dr. H. B. Mills, Montana State College; Professor H. J. Reinhard, Texas A. and M. College; Professor C. W. Sabrosky, Michigan State College; Professor G. J. Spencer and Mr. J. K. Jacob, University of British Columbia; Mr. C. Garrett, Cranbrook, British Columbia; Mr. Ian Moore, San Diego, California; Mr. P. C. Ting, San Francisco, California; Dr. C. E. Mickel and Mr. D. Denning, University of Minnesota; Professor E. H. Strickland, University of Alberta; Mr. G. Steyskal, Detroit, Michigan; Dr. W. E. Shull, University of Idaho; Dr. R. D. Shenefelt, Washington State College; Dr. H. K. Townes, formerly at Cornell University; Dr. D. M. Rees, University of Utah; Dr. R. H. Painter and Professor D. A. Wilbur, Kansas State College; Dr. C. S. Brimley, North Carolina Department of Agriculture; Mr. Charles F. Henderson, Whittier, California; Dr. H. C. Severin, South Dakota State College; Professor C. L. Hayward, Brigham Young University; Mr. Pedrito Silva, Instituto de Cacau da Bahia; Mr. M. P. Reidel, Frankfurt Oder; Dr. H. de Souza Lopes, Instituto Oswaldo Cruz; Mr. Fritz Plaumann, Nova Teutonia, Brazil; Dr. Edward S. Thomas, Ohio State Museum; Dr. C. H. Ballou, Estacion Experimental de Agricultura, Venezuela; Dr. J. N. Knull, Ohio State Unversity; Mr. Mont A. Cazier, American Museum; and Dr. T. H. Frison, University of Illinois.

* These acknowledgments also refer to the author's studies of the Dorilaidae.

INDEX TO GENERIC AND SPECIFIC NAMES

PAGE
abbreviatus Loew, Bibio 450
abbreviatus Van der Wulp, Bibio; homonym 450
Acanthocnemis Blanchard, syn. of Philia 497
aestiva Melander, Bibiodes 494
afer McAtee, Bibio; = carolinus n. n.* 457
alacris Curran, Plecia 395
albipennis Say, Bibio 451
albipennis beameri n. sub. sp. 451
albipennis hirtus Loew 452
albipennis var. tenuipes Coquillett 453
alexanderi James, Bibio 453
alienus McAtee, Bibio 454
americana Hardy, Plecia 395
appendicula n. sp., Penthetria 384
arizonaensis Hardy, Philia 500
articulatus Say, Bibio; = abbreviatus Loew? 450, 465
ater Macquart, Penthetria; syn. of heteroptera (Say) 386
atra Macquart, Penthetria; syn. of heteroptera (Say) 386
atripilosus James, Bibio 455
avicephaliforma Hardy, Plecia 396
baltimoricus Macquart, Bibio; = abbreviatus Loew? 450
basalis Loew, Bibio 456
bellardi Townsend, Plecia; syn. of plagiata Wiedemann 427
biarmata Hardy, Plecia 397
Bibio Geoffroy 444
Bibiodes Coquillett 494
Bibionellus Edwards 496
bicolor Bellardi, Plecia 398
biformis Hardy, Plecia 399
bimaculata Walker, Plecia ?; cannot be placed 514
brazilana Hardy, Plecia 400
breviceps (Loew), Philia 501
breviceps var. atelestes Hardy 502
brevifrons Walker, Hesperinus 382
brunnipes Fabricius, Bibio; cannot be placed 493
bryanti Johnson, Bibio 456
bryanti var. nigrita Curran 457
canadensis Macquart, Bibio; syn. of xanthopus Wied. ? 491
carolinus n. n., Bibio; n. n. for afer McAtee 457
carri Curran, Bibio 458
castanipes Jaennicke, Bibio cannot be placed 493
caurina (McAtee), Philia 502
cognatus Hardy, Bibio 459
collaris (Fabricius), Plecia 401
columbiaensis Hardy, Bibio 459

* n. n.=new name.

PAGE
confusa Loew, Plecia; c.n. ** for ruficollis Fabr. ... 402
conjunctivus Hardy, Bibio ... 460
conus Hardy, Bibio ... 461
costalis Walker, Penthetria; syn. of nigerrima (Bellardi) ... 388
costalis Wiedemann, Plecia ... 404
criorhinus Bellardi, Bibio ... 462
currani Hardy, Bibio; c.n. for lacteipennis Curran = syn. of bryanti Johnson ... 456
currani var. nigrita Curran, = bryanti var. nigrita Curran ... 457
curtipes James, Bibio ... 462
curvistylata Hardy, Plecia ... 405
dentata Hardy, Plecia ... 405
Dilophus Meigen, syn. of Philia Meigen ... 497
dimidiatus Loew, Philia; syn. of spinipes (Say) ... 510
discolor Van der Wulp, Plecia ... 406
disparis Hardy, Plecia ... 406
distincta n.sp., Penthetria ... 385
ecuadorensis Hardy, Plecia ... 460
ecuadorensis micans Hardy ... 407
edwardsi Hardy, Plecia ... 408
emarginata (McAtee), Philia ... 303
Eupeitenus Macquart, syn. of Penthetria Meigen ... 384
febrilis (Linn.), Philia ... 374, 498
femorata Melander, Bibiodes ... 495
femorata Macquart, Plecia; cannot be placed ... 443
femoratus Wiedemann, Bibio ... 463
ferruginatus Linn., Bibio ... 374
flagellaria Garrett, Hesperinus ... 383
flavimaculata Hunter, Plecia; = fulvimacula Walker ... 408
fluginatus Hardy, Bibio ... 464
flukei Hardy, Bibio ... 464
fraternus Loew, Bibio ... 465
fulvicoxa (Walker), Philia ... 503
fulvimacula Walker, Plecia ... 408
fumidus Coquillett, Bibio; syn. of inaequalis Loew ... 468
fumipennis Walker, Bibio ... 466
funebris (Fabricius), Plecia; = plagiata Wiedemann ? ... 427
fuscipennis Macquart, Bibio; syn. of femoratus Wied. ... 463
gibbosa Hardy, Plecia ... 409
gracilis Walker, Bibio; slossonae Cock. = c.n. ... 486
grisea Edwards, Plecia ... 410
halteralis Coquillett, Bibiodes ... 496
Hesperinus Walker ... 382
heteroptera (Say), Penthetria ... 386
heteroptera Macquart, Plecia; syn. of plagiata Wied. ... 427
hirtus Loew, Bibio; = albipennis hirtus Loew ... 452
holtii McAtee, Bibio ... 467

**c. n.—change of name.

PAGE
hortulanus Linn., Bibio 371, 374
humeralis Walker, Bibio; syn. of xanthopus Wied.? 491
imperialis Schiner, Plecia 411
impilosa Hardy, Plecia 412
inaequalis Loew, Bibio 468
incurvata Hardy, Plecia 413
jacobi Hardy (nec Villeneuve), Bibio; = neojacobi n.n. 476
jacobi var. rufitibialis Hardy, = neojacobi var. rufitibialis Hardy 477
jamesi Hardy, Philia 504
johannis Linn., Bibio 374, 377
kansensis James, Bibio 469
knowltoni Hardy, Bibio 469
knowltoni var. paltidus Hardy 470
labradorensis Johnson, Bibio 471
lacteipennis Zetterstedt, Bibio 378
lacteipennis Curran (nec Zett.), Bibio; syn. of bryanti Johnson 456
lateralis Hardy, Plecia 413
lindneri Edwards, Plecia 414
lobatus Hardy, Bibio 471
longiceps (Loew), Philia; cannot be placed 514
longipes Loew, Bibio 472
longipes Loew, Penthetria; syn. of heteroptera (Say) 386
lopesi Hardy, Plecia 415
lucens Hardy Bibio; syn. of nigripilus Loew 480
lugens Loew, Bibio; syn. of xanthopus Wied 491
macateei James, Bibio; syn. of xanthopus Wied 491
maculata Hardy, Plecia 416
marci Linn., Bibio 374, 377, 379
marginata Edwards, Plecia 417
maura Walker, Plecia 417
melanopilosus Hardy, Bibio 473
melanopilosus var. biseptus Hardy 473
mexicana (Hardy), Penthetria 387
mickeli Hardy, Bibio 474
minor Jaennicke, Plecia; syn. of similis Rondani 439
monstri James, Bibio 475
nearctica Hardy, Plecia 418
necotus Hardy, Bibio 476
neojacobi n.n., Bibio; n.n. for jacobi Hardy 476
neojacobi rufitibialis Hardy 477
nervosus Loew, Bibio 477
nigerrima (Bellardi), Penthetria 388
nigra (Philippi), Plecia 419
nigrifemoratus Hardy, Bibio 478
nigrifemoratus var. gilvus Hardy 479
nigripilus Loew, Bibio 480
nigrita Perty, Penthetria 389
nitidicollis Edwards, Plecia 420
nitidipes Edwards, Plecia 421

PAGE
obesula (Loew), Philia 505
obscurus Loew, Bibio; syn. of xanthopus Wiedemann 491
occipitalis Coquillett, Philia; syn. of breviceps (Lw.) 501
oklahomensis Hardy, Philia 506
orbata (Osten Sacken), Philia 507
orbatus Say, Bibio; cannot be placed 493
painteri James, Bibio 480
pallipes Say, Bibio; syn. of abbreviatus Loew ? 450
panamaensis Hardy, Plecia 422
parvistylata Hardy, Plecia 423
Penthera Philippi, syn. of Plecia Wied. 390
Penthetria Meigen 384
perplexa Hardy, Plecia 423
persimilis Hardy, Plecia 424
pertinens Hardy, Plecia 425
Philia Meigen 497
pictipennis Edwards, Plecia 426
pictipennis var. rufovittata Edwards 427
pingreensis James, Bibio 481
plagiata Wiedemann, Plecia 427
Plecia Wiedemann 390
Protoplecia Handlirsch 380
proxima (McAtee), Philia 508
pruinosa Hardy, Plecia 428
punctulata Hardy, Plecia 429
pusillus (Wiedemann), Philia; cannot be placed 514
quadrivittata Williston, Plecia 430
rectiora Hardy, Plecia 431
Rhinoplecia Bellardi, syn. of Plecia 390
rostellata Loew, Plecia 432
rostrata Bellardi, Plecia; syn. of rostellata Loew 432
rufalipes Hardy, Bibio 482
ruficollis Fabr., Plecia; confusa Loew = c. n. 402
rufimarginata Hardy, Plecia 433
rufipes Fabr., Bibio; cannot be placed 494
rufiscutella Hardy, Plecia 433
rufithorax Wied., Bibio 483
rufithorax Walker, Plecia 434
rufithorax concava Hardy 435
rugosa Hardy, Plecia 436
scita Walker, Bibio; syn. of xanthopus Wied? 491
secta (McAtee), Philia 508
seminitens Edwards, Plecia 437
senilis Wulp, Bibio; syn. of femoratus Wied. 463
sereri Massalongo, Bibio 380
sericatus Hardy, Bibio 484
serotina (Loew), Philia 509
serrata Hardy, Plecia 438

PAGE
serraticollis (Walker), Philia; cannot be placed 514
signatus Hardy, Bibio; syn. of xanthopus palliatus McAtee 492
similis Rondani, Plecia 439
similis James, Bibio 485
simplicis Curran, Bibio; syn. of inaequalis Loew 468
slossonae Cockerell, Bibio; c. n. for gracilis Walker 486
spinipes (Say), Philia 510
Spodius Loew, syn. of Hesperinus Walker 382
stigmatera (Say), Philia 511
stigmatera var. nigra Hardy 511
striatipes Walker, Bibio; cannot be placed 494
strigilata (McAtee), Philia 512
tenellus Hardy, Bibio 486
tenuipes Coquillett, Bibio; = albipennis var. tenuipes Coq. 453
thoracica Say, Bibio; syn. of rufithorax Wied 483
thoracicus Say, Philia; syn. of spinipes (Say) 510
tibialis (Loew), Philia 512
tibialis Edwards, Bibionellus 497
tingi n. sp., Philia 513
townesi n. sp., Bibio 487
trilobata Hardy, Plecia 440
tristis Williston, Bibio 488
uberta Hardy, Plecia 441
utahensis Hardy, Bibio 489
varabilis Hardy, Plecia 441
variabilis Loew, Bibio; syn. of nervosus Loew 477
velcidus Hardy, Bibio 490
velorum McAtee, Bibio 490
velutina Macquart, Plecia; syn. of maura Walker 417
vestitus Walker, Bibio 491
vittata Wiedemann, Plecia 442
vittata Bellardi, Plecia; syn. of plagiata Wied. 427
xanthopus Wiedemann, Bibio 491
xanthopus palliatus McAtee 492
xenia Hardy, Plecia 443

PLATE XXIX

FIG. 110. *Philia orbata* (Osten Sacken). a. female reproductive system, right ovary, dorsal view; c. o. = common oviduct, ac. gl. = accessory glands, sp. = spermathecae.

FIG. 111. *Bibio marci* Linn. (Drawings copied from Morris) a. right mandible of larva; b. right maxilla of larva; c. spicules on cuticula of larva.

FIG. 112. *Bibio lacteipennis* Zett. a. portion of larval cuticula (after Morris).

FIG. 113. *Bibio johannis* Linn. a. larval cuticula (after Morris).

FIG. 114. *Bibio pomonae* Fab. a. larval cuticula (after Morris).

FIG. 115. *Bibio venosus* Mg. a. larval cuticula (after Morris).

FIG. 116. *Philia febrilis* (Linn.) a. larval cuticula (after Morris).

FIG. 117. *Bibio melanopilosus* var. *bisepta* Hardy. a. spicules of larva.

FIG. 118. *Bibio xanthopus* Wiedemann. a. spicules of larva.

FIG. 119. *Bibio xanthopus palliatus* McAtee. a. spicules of larva.

FIG. 120. *Bibio sp?* a. spicules of larva.

FIG. 121. *Hesperinus brevifrons* Walker. a. wing; b. ninth tergum of male; c. lateral view of harpago and distal portion of ninth sternum and tergum; d. harpago, dorsal view; e. left harpago and portion of ninth sternum, ventral.

FIG. 122. *Penthetria appendicula* n. sp. a. male hypopygium, ventral; b. ninth tergum of male, dorsal; c. portion of wing.

FIG. 123. *P. distincta* n. sp. a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 124. *P. heteroptera* (Say). a. male hypopygium, ventral; b. eighth sternum of female; c. ninth tergum of male; d. female genitalia, dorsal.

PLATE XXIX

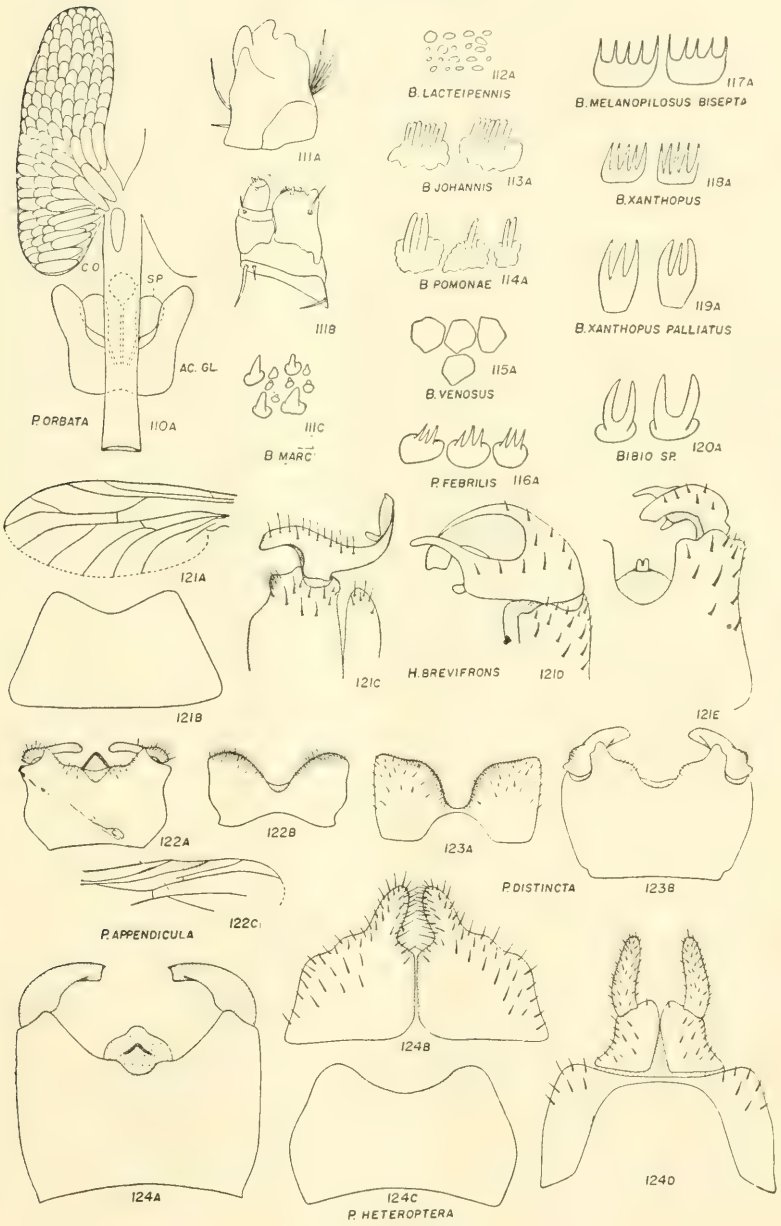

C O
SP
AC. GL
P. ORBATA
110A
111A
111B
111C
B. MARC
112A
B. LACTEIPENNIS
B. JOHANNIS
113A
B. POMONAE
114A
115A
B. VENOSUS
P. FEBRILIS
116A
117A
B. MELANOPILOSUS BISEPTA
118A
B. XANTHOPUS
119A
B. XANTHOPUS PALLIATUS
BIBIO SP.
120A
121A
121B
121C
H. BREVIFRONS
121D
121E
122A
122B
122C
P. APPENDICULA
123A
P. DISTINCTA
123B
124A
124B
124C
P. HETEROPTERA
124D

PLATE XXX

FIG. 125. *P. mexicana* (Hardy). a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 126. *P. nigerrima* (Bellardi). a. male genitalia, ventral; b. ninth tergum of male.

FIG. 127. *P. nigrita* Perty. a. male genitalia, ventral; b. ninth tergum of male.

FIG. 128. *Plecia alacris* Curran. a. costal margin of wing; b. male hypopygium, ventral; c. lateral of harpago; d. ninth tergum of male.

FIG. 129. *P. americana* Hardy. a. eighth sternum of female; b. ninth tergum and cerci of female; c. ninth tergum of male; d. male hypopygium, ventral.

FIG. 130. *P. avicephaliforma* Hardy. a. costal margin of wing; b. male hypopygium, ventral; c. harpago, lateral; d. ninth tergum of male.

FIG. 131. *P. biarmata* Hardy, a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 132. *P. bicolor* Bellardi. a. male harpago, lateral; b. male hypopygium, ventral; c. ninth tergum, dorsal; d. ninth tergum and cerci of female; e. female genitalia, ventral.

PLATE XXX

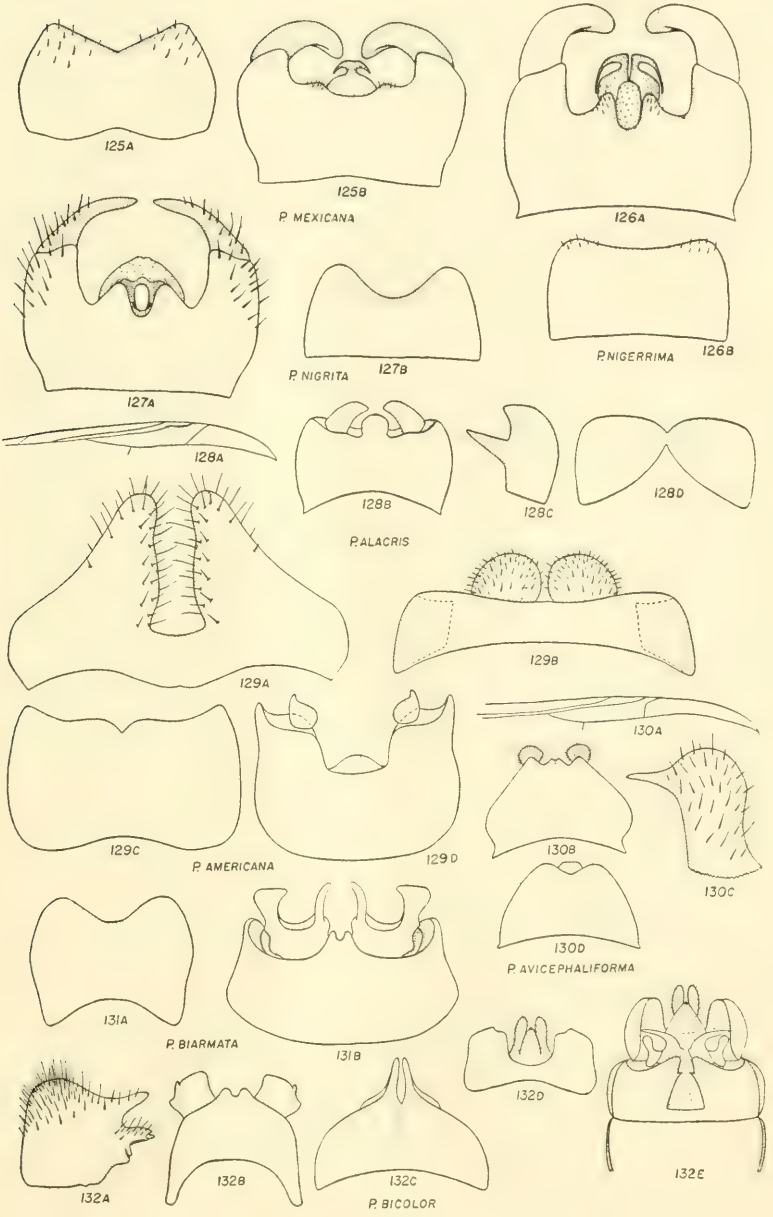

125A
125B
P. MEXICANA
126A
127A
P. NIGRITA
127B
P. NIGERRIMA
126B
128A
128B
128C
128D
P. ALACRIS
129A
129B
130A
129C
P. AMERICANA
129D
130B
130C
130D
P. AVICEPHALIFORMA
131A
P. BIARMATA
131B
132A
132B
132C
P. BICOLOR
132D
132E

PLATE XXXI

FIG. 133. *P. biformis* Hardy. a. male hypopygium, ventral; b. ninth tergum of male; c. eighth sternum of female; d. female genitalia, dorsal.

FIG. 134. *P. brazilana* Hardy. a. wing; b. male hypopygium, ventral; c. ninth tergum of male.

FIG. 135. *P. collaris* (Fabricius). a. female genitalia, dorsal view; b. female genitalia, ventral; c. harpago, right lateral; d. ninth tergum of male; e. male hypopygium, ventral.

FIG. 136. *P. confusa* Loew. a. male hypopygium, ventral; b. lateral of male harpago; c. ninth tergum and cerci of male; d. costal margin of wing.

FIG. 137. *P. curvistylata* Hardy. a. costal margin of wing; b. harpago, lateral; c. male hypopygium, ventral; d. ninth tergum of male.

FIG. 138. *P. dentata* Hardy. a. costal margin of wing; b. lateral view of harpago; c. male hypopygium, ventral; d. ninth tergum of male.

FIG. 139. *P. disparis* Hardy. a. male hypopygium, ventral; b. ninth tergum of male.

PLATE XXXI

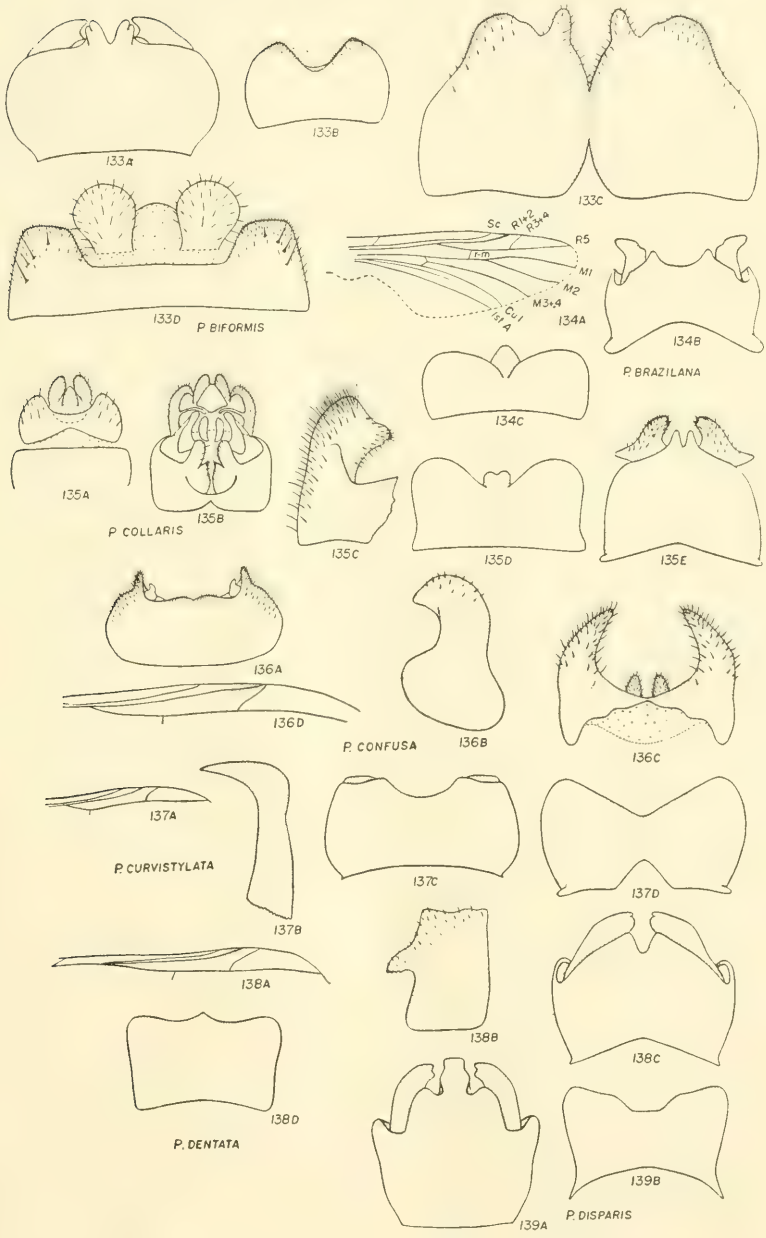

133A
133B
133C
133D
P. BIFORMIS
Sc
R1+2
R3+4
R5
r-m
M1
M2
M3+4
Cu1
1st A
134A
134B
P. BRAZILANA
134C
135A
135B
P. COLLARIS
135C
135D
135E
136A
136D
P. CONFUSA
136B
136C
137A
P. CURVISTYLATA
137B
137C
137D
138A
138B
138C
138D
P. DENTATA
139A
139B
P. DISPARIS

PLATE XXXII

FIG. 140. *P. ecuadorensis* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 141. *P. ecuadorensis micans* Hardy. a. eighth tergum of female; b. female genitalia, dorsal.

FIG. 142. *P. edwardsi* Hardy. a. male hypopygium, ventral; b. ninth tergum of male.

FIG. 143. *P. gibbosa* Hardy, a. ninth tergum of female; b. eighth sternum of female; c. ninth tergum of male, and view; d. ninth tergum of male, dorsal; e. ninth sternum and harpagones of male, ventral.

FIG. 144. *Plecia grisea* Edwards. a. ninth sternum and harpagones of male, ventral; b. ninth tergum of male.

FIG. 145. *P. imperialis* Schiner. a. male hypopygium ventral view showing left harpago folded down in natural position; b. ninth tergum of male.

PLATE XXXII

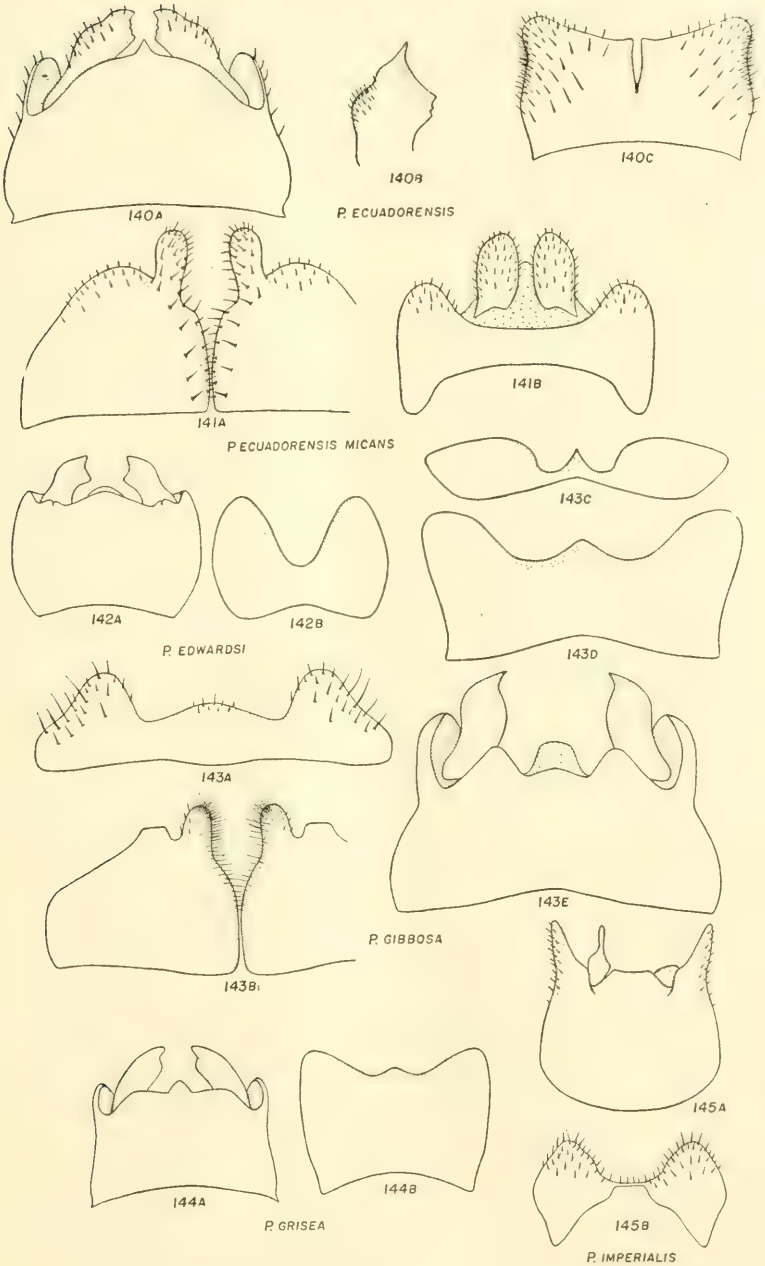

140A
140B
P. ECUADORENSIS
140C
141A
P. ECUADORENSIS MICANS
141B
142A
142B
P. EDWARDSI
143C
143D
143A
143E
P. GIBBOSA
143B
144A
144B
P. GRISEA
145A
145B
P. IMPERIALIS

PLATE XXXIII

FIG. 146. *P. impilosa* Hardy. a. hypopygium of male, ventral; b. ninth tergum of male.

FIG. 147. *P. incurvata* Hardy. a. male hypopygium, ventral; b. costal margin of wing; c. ninth tergum of male.

FIG. 148. *P. lateralis* Hardy. a. ninth sternum and harpagones of male, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 149. *P. lindneri* Edwards. a. ninth sternum and harpagones of male, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 150. *P. lopesi* Hardy. a. antenna; b. ninth sternum and harpagones, ventral; c. ninth tergum of male.

FIG. 151. *P. maculata* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. costal margin of wing; d. ninth tergum of male.

FIG. 152. *P. maura* Walker. a. ninth sternum and harpagones of male, ventral; b. ninth tergum of male; c. eighth sternum of female; d. female genitalia, dorsal.

FIG. 153. *P. nearctica* Hardy. a. ninth tergum of male; b. male hypopygium, ventral; c. male harpago, lateral; d. eighth sternum of female; e. ninth tergum and cerci of female, tergum flattened to show shape. (See also Fig. 153 on Plate XXXIV.)

PLATE XXXIII

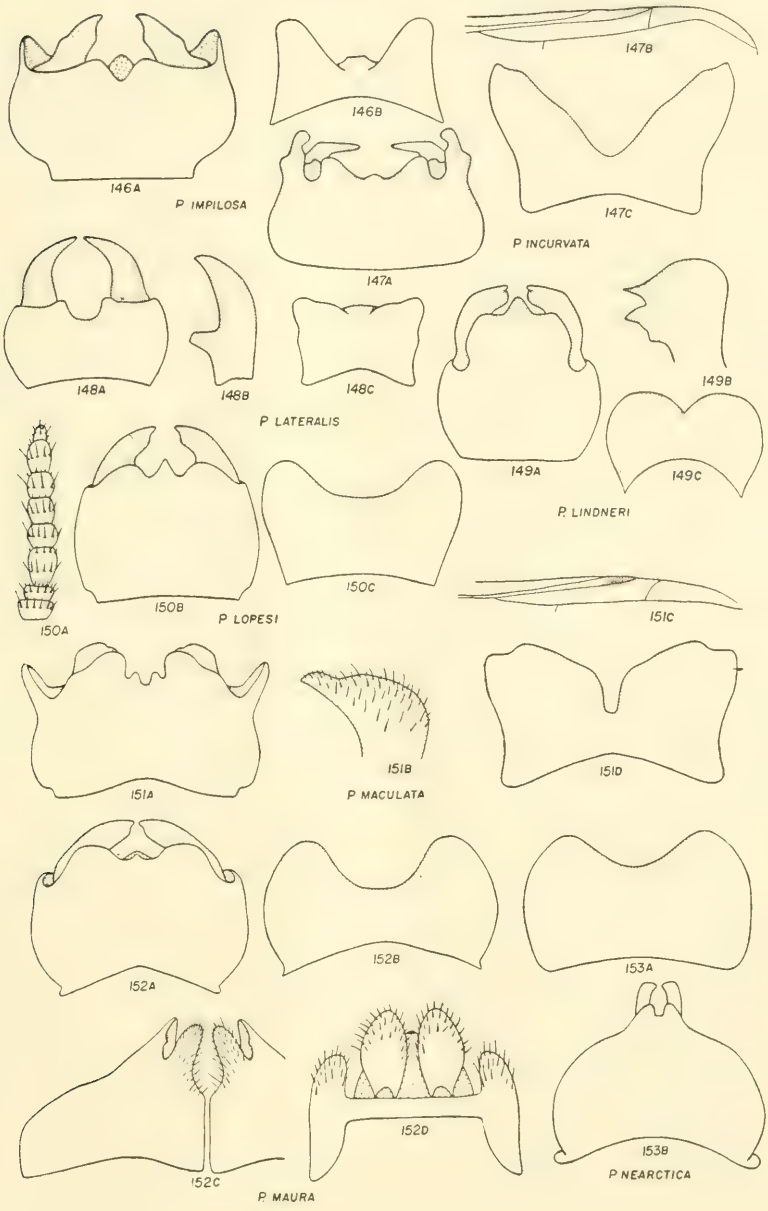


PLATE XXXIV

FIG. 153. *P. nearctica* Hardy. a. ninth tergum of male; b. male hypopygium, ventral; c. male harpago, lateral; d. eighth sternum of female; e. ninth tergum and cerci of female, tergum flattened to show shape. (See also Fig. 153 on Plate XXXIII.)

FIG. 154. *P. nigra* (Philippi). a. costal margin of wing; b. ninth tergum of male; c. ninth sternum and harpagones of male.

FIG. 155. *P. nitidicollis* Edwards. a. ninth tergum of male; b. male hypopygium, ventral; c. harpago, lateral.

FIG. 156. *P. nitidipes* Edwards. a. male hypopygium, ventral; b. ninth tergum of male; c. female genitalia, ventral; d. ninth tergum of female.

FIG. 157. *P. panamaensis* Hardy. a. eighth sternum of female; b. ninth tergum of male; c. male hypopygium, ventral; d. ninth tergum of female.

FIG. 158. *P. parvistylata* Hardy. a. ninth sternum and harpagones of male; b. ninth tergum of male.

FIG. 159. *P. perplexa* Hardy. a. ninth tergum of male, dorsal; b. ninth tergum, end view; c. male hypopygium, ventral; d. male hypopygium, dorsal view with tergum removed.

PLATE XXXIV

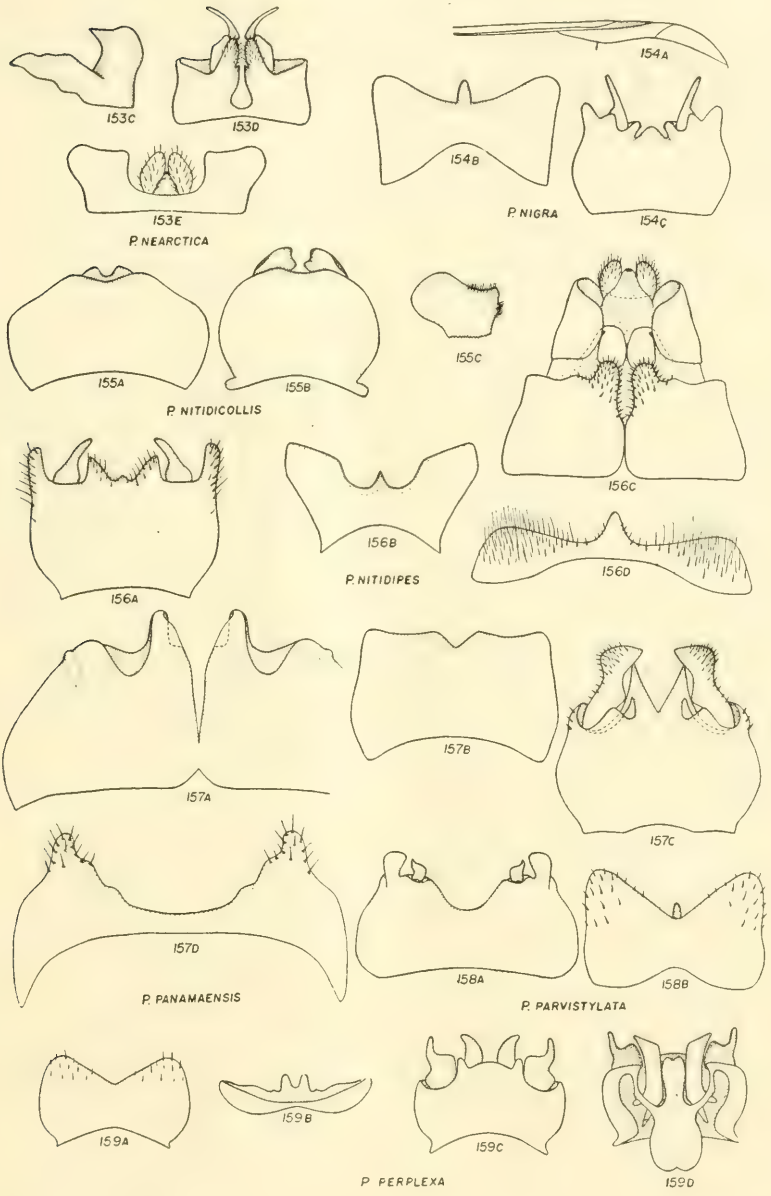

153C
153D
153E
P. NEARCTICA
154A
154B
P. NIGRA
154C
155A
155B
P. NITIDICOLLIS
155C
156C
156A
156B
P. NITIDIPES
156D
157A
157B
157C
157D
P. PANAMAENSIS
158A
158B
P. PARVISTYLATA
159A
159B
159C
P. PERPLEXA
159D

PLATE XXXV

FIG. 160. *P. persimilis* Hardy. a. ninth sternum and harpagones of male; b. harpago, lateral; c. female genitalia, ventral; d. ninth tergum of male; e. ninth tergum of female.

FIG. 161. *P. pertinens* Hardy, a. male hypopygium, ventral; b. ninth tergum of male; c. harpago, lateral; d. female genitalia, ventral; e. costal margin of male wing; f. costal margin of female wing; g. female genitalia, dorsal.

FIG. 162. *P. pictipennis* Edwards. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum and sternum of male; dorsal view showing dorsal extension of sternum.

FIG. 163. *P. plagiata* Wiedemann. a. male hypopygium, ventral; b. ninth tergum of male; c. eighth sternum of female; d. female genitalia, dorsal.

FIG. 164. *P. pruinosa* Hardy. a. male hypopygium, ventral; b. ninth tergum of male.

FIG. 165. *P. punctulata* Hardy. a. ninth tergum of male; b. male hypopygium, ventral.

PLATE XXXV

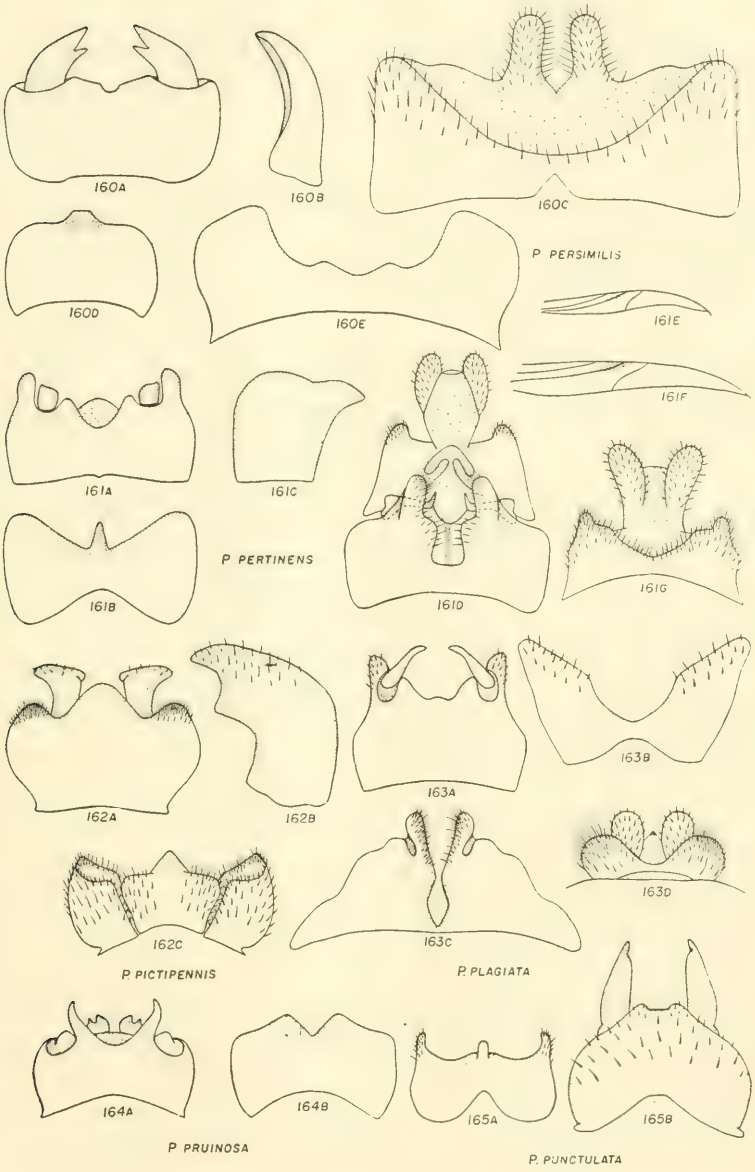

160A
160B
160C
160D
160E
P. PERSIMILIS
161E
161F
161A
161C
161B
P. PERTINENS
161D
161G
162A
162B
163A
163B
162C
P. PICTIPENNIS
163C
P. PLAGIATA
163D
164A
164B
165A
165B
P. PRUINOSA
P. PUNCTULATA

PLATE XXXVI

FIG. 166. *P. quadrivittata* Williston. a. eighth sternum of female; b. male hypopygium, ventral; c. aedeagus and accessory structures; d. ninth tergum of male; e. ninth tergum and cerci of female.

FIG. 167. *P. rectiora* Hardy. a. male hypopygium, ventral; b. accessory plate at side of aedeagus; c. ninth tergum of male.

FIG. 168. *P. rostellata* Loew. a. eighth sternum of female; b. ninth tergum of female; c. male hypopygium, ventral; d. ninth tergum of male.

FIG. 169. *P. rufimarginata* Hardy. a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 170. *P. rufiscutella* Hardy. a. ninth tergum of male; b. male hypopygium, ventral.

FIG. 171. *P. rufithorax* Walker. a. ninth tergum of female; b. ninth tergum of male; c. costal margin of wing; d. eighth sternum of female.

PLATE XXXVI

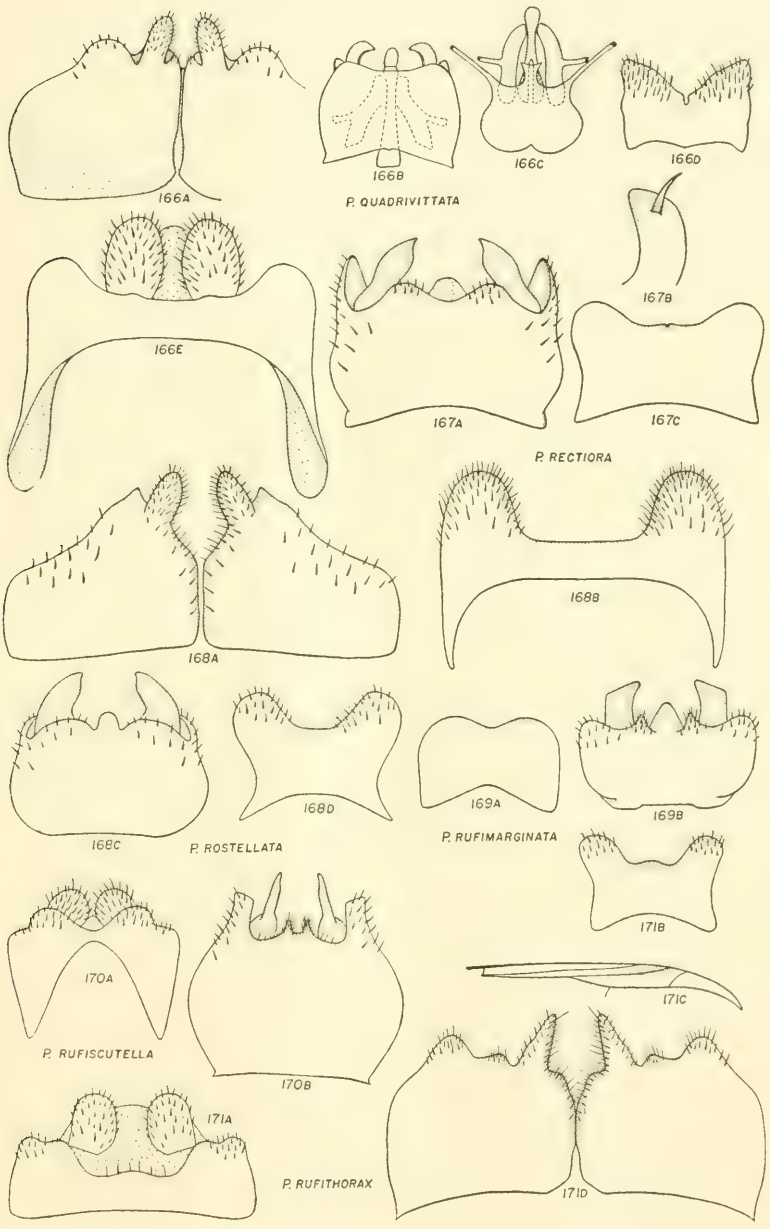

166A
166B
P. QUADRIVITTATA
166C
166D
166E
167B
167A
167C
P. RECTIORA
168A
168B
168C
168D
P. ROSTELLATA
169A
169B
P. RUFIMARGINATA
171B
170A
P. RUFISCUTELLA
170B
171C
171A
P. RUFITHORAX
171D

PLATE XXXVII

FIG. 172. *P. rufithorax concava* Hardy. a. male hypopygium, ventral; b-c. variations in appearance of median process of ninth sternum, caused mostly by amount of tilting; d. ninth tergum of male; e. ninth tergum of female; f. eighth sternum of female.

FIG. 173. *P. rugosa* Hardy. a. male genitalia, ventral; b. ninth tergum of male, dorsal; c. ninth tergum, end view.

FIG. 174. *P. seminitens* Edwards. a. male genitalia, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 175. *P. serrata* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 176. *P. similis* Rondani. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 177. *P. trilobata* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male, dorsal; d. ninth tergum, end view somewhat diagrammatic.

FIG. 178. *P. uberta* Hardy. a. male hypopygium, ventral; b. ninth tergum of male; c. harpago, lateral; d. ninth tergum of female; e. eighth sternum of female.

PLATE XXXVII

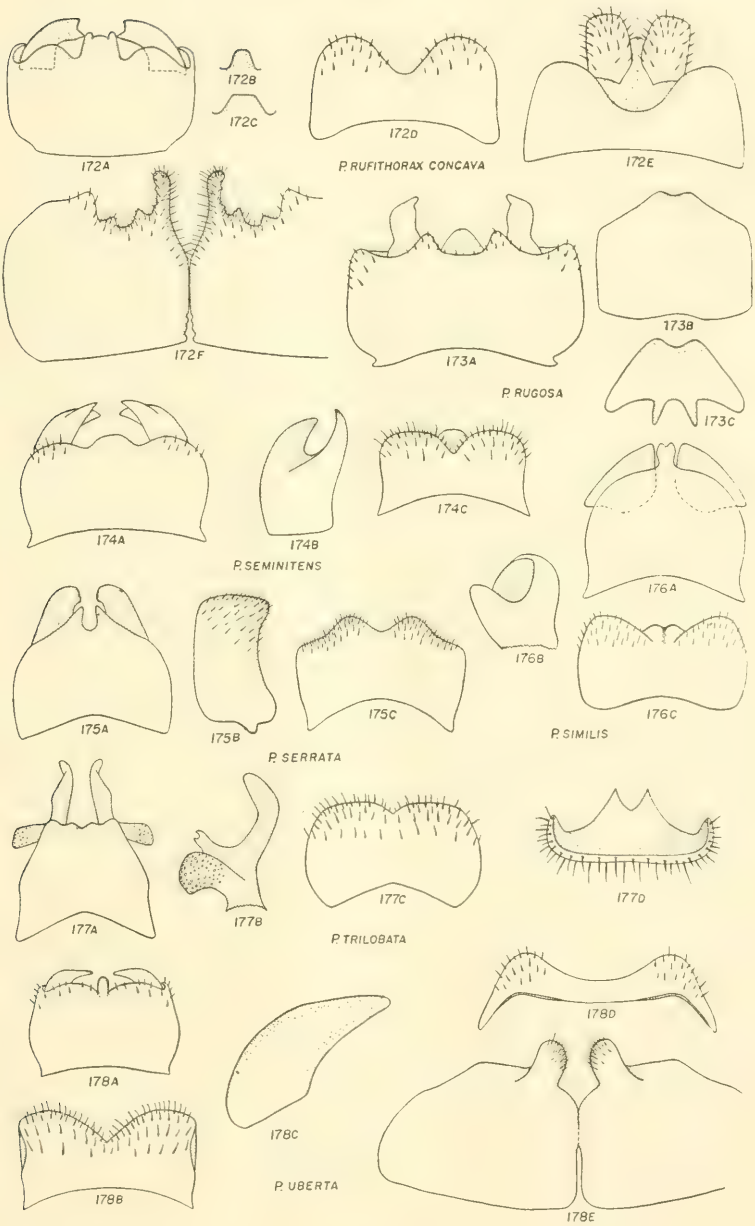


PLATE XXXVIII

FIG. 179. *P. varabilis* Hardy. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 180. *P. vittata* Wiedemann. a. male hypopygium, ventral; b. harpago, lateral; c. ninth tergum of male.

FIG. 181. *P. xenia* Hardy. a. ninth tergum of female; b. ninth tergum of male; c. harpago, lateral; d. male hypopygium, ventral; e. eighth sternum of female.

FIG. 182. *Bibio abbreviatus* Loew. a. ninth sternum and harpagones of male; b. posterior tarsus and apex of tibia of male; c. ninth tergum of male.

FIG. 183. *B. albipennis* Say. a. posterior basitarsus and tibial spurs.

FIG. 184. *B. albipennis beameri* n. sub. sp. a. ninth sternum and harpagones of male; b. ninth tergum of male.

FIG. 185. *B. albipennis* var. *tenuipes* Coq. a. anterior tibia of male.

FIG. 186. *B. atripilosus* James. a. ninth sternum and harpagones of male; b. ninth tergum and cerci of male.

FIG. 187. *B. carolinus* n. n. a. head of female, lateral; b. ninth sternum and harpagones of male, ventral; c. ninth tergum of male; d. posterior tibia and tarsus of male.

FIG. 188. *B. carri* Curran. a. posterior tarsus and tibial spur, lateral; b. ninth tergum of male.

PLATE XXXVIII

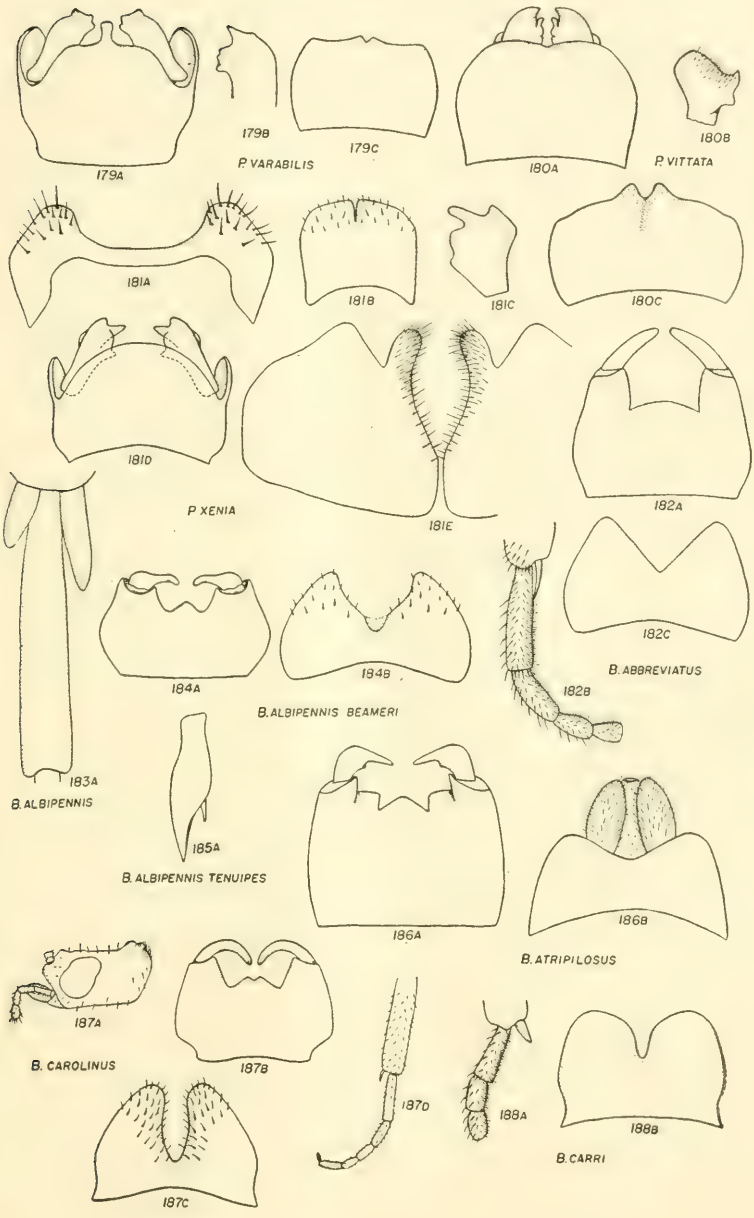


PLATE XXXIX

FIG. 189. *B. femoratus* Wiedemann. a. anterior tibia of male.

FIG. 190. *B. flukei* Hardy. a. posterior basitarsus and tibial spurs of male.

FIG. 191. *B. fraternus* Loew. a. posterior tarsus and tibial spurs of male, lateral; b. ninth tergum of male.

FIG. 192. *B. holti* McAtee. a. anterior tibia of male.

FIG. 193. *B. inaequalis* Loew. a. front tibia, lateral; b. front tibia, dorsal; c. ninth tergum of male; d. ninth sternum and harpagones.

FIG. 194. *B. kansensis* James. a. posterior metatarsus and apex of tibia of male, lateral.

FIG. 195. *B. knowltoni* var. *paltidus* Hardy. a. posterior tarsus and apex of tibia, lateral.

FIG. 196. *B. longipes* Loew. a. apex of front tibia and metatarsus of male; b. posterior metatarsus and tibial spurs of male.

FIG. 197. *B. melanopilosus* Hardy. a. wing; b. posterior metatarsus and tibial spurs of male; c. head of male.

FIG. 198. *B. monstri* James. a. ninth sternum and harpagones of male; b. harpago, dorsal; c. ninth tergum of male.

FIG. 199. *B. nervosus* Loew. a. ninth tergum of male; b. ninth sternum and harpagones; c. anterior tibia of male.

FIG. 200. *B. pingreensis* James. a. posterior metatarsus and tibial spurs of male.

FIG. 201. *B. rufithorax* Wiedemann. a. wing; b. head of female; c. ninth sternum and harpagones of male; d. front tibia; e. posterior tarsus of male; f. ninth tergum of male. (See also Fig. 201 on Plate XL.)

PLATE XXXIX

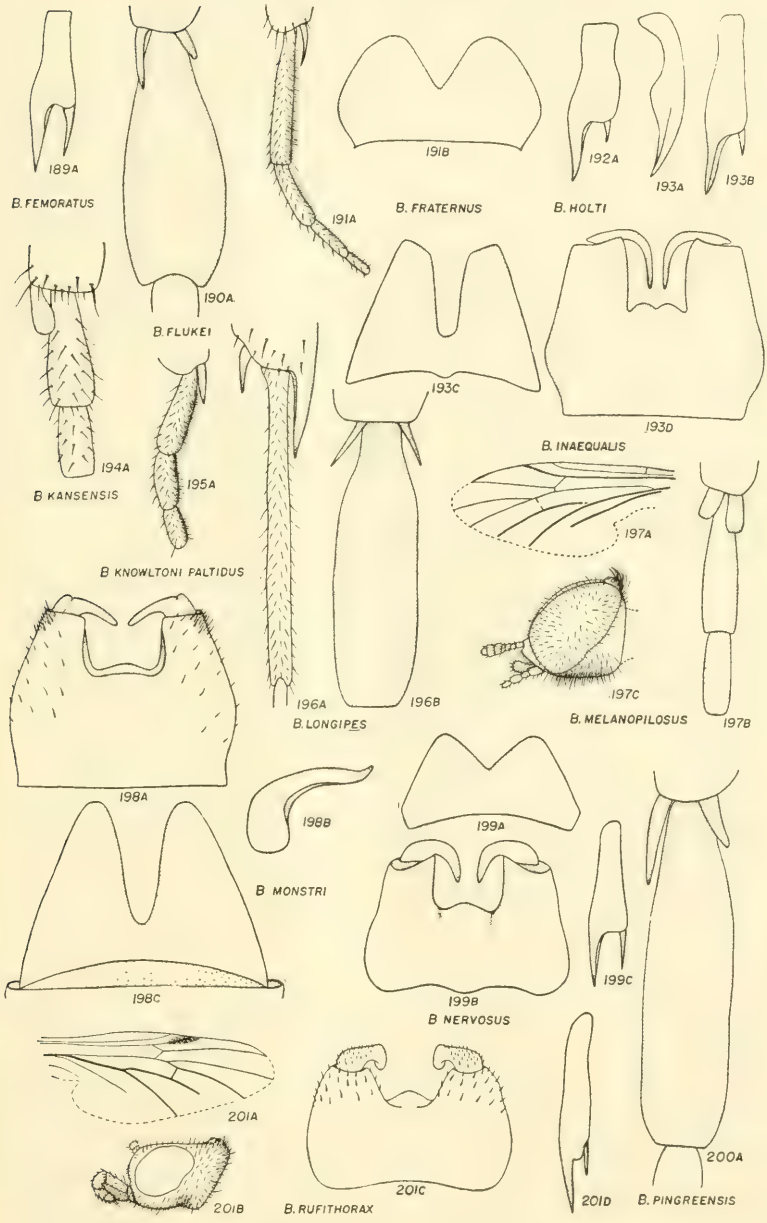

189A
B. FEMORATUS
190A
B. FLUKEI
191A
191B
B. FRATERNUS
192A
193A
193B
B. HOLTI
193C
193D
B. INAEQUALIS
194A
B. KANSENSIS
195A
B. KNOWLTONI PALTIDUS
196A
196B
B. LONGIPES
197A
197C
B. MELANOPILOSUS
197B
198A
198B
B. MONSTRI
198C
199A
199B
B. NERVOSUS
199C
200A
B. PINGREENSIS
201A
201B
201C
B. RUFITHORAX
201D

PLATE XL

FIG. 201. *B. rufithorax* Wiedemann. a. wing; b. head of female; c. ninth sternum and harpagones of male; d. front tibia; e. posterior tarsus of male; f. ninth tergum of male. (See also Fig. 201 on Plate XXIX.)

FIG. 202. *B. sericatus* Hardy. a. anterior metatarsus and tibial spurs of male; b. posterior metatarsus and tibial spurs.

FIG. 203. *B. townesi* n. sp. a. male genitalia, lateral.

FIG. 204. *B. xanthopus* Wiedemann. a. anterior tibia of male.

FIG. 205. *Bibiodes aestiva* Melander. a. male hypopygium, ventral; b. ninth tergum and cerci of male; c. wing.

FIG. 206. *B. femorata* Melander. a. male hypopygium, ventral; b. ninth tergum of male.

FIG. 207. *B. halteralis* Coquillett. a. male hypopygium, ventral; b. ninth tergum of male, showing left harpago and portion of sternum in dorsal view.

FIG. 208. *Philia breviceps* (Loew). a. male hypopygium, ventral; b. harpago, dorsal; c. harpago, lateral; d. ninth tergum of male.

FIG. 209. *P. caurina* (McAtee). a. ninth sternum and harpagones; b. harpago, lateral; c. ninth tergum of male.

FIG. 210. *P. emarginata* (McAtee). a. ninth tergum of male; b. ninth sternum and harpagones.

FIG. 211. *P. oklahomensis* Hardy. a. ninth sternum and harpagones, ventral; b. harpago, lateral; c. wing; d. ninth tergum of male.

PLATE XL

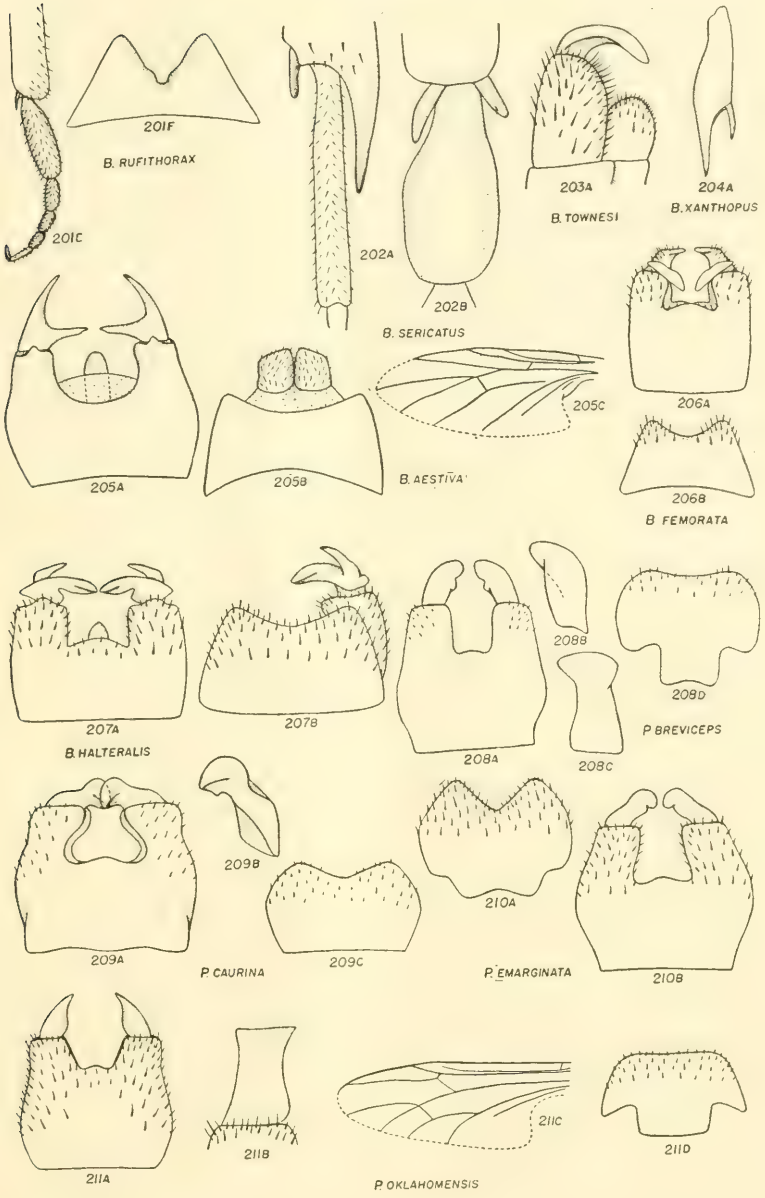

201C
201F
B. RUFITHORAX
202A
202B
B. SERICATUS
203A
B. TOWNESI
204A
B. XANTHOPUS
205A
205B
205C
B. AESTIVA
206A
206B
B. FEMORATA
207A
B. HALTERALIS
207B
208A
208B
208C
209D
P. BREVICEPS
209A
209B
P. CAURINA
209C
210A
P. EMARGINATA
210B
211A
211B
211C
211D
P. OKLAHOMENSIS

PLATE XLI

FIG. 212. *P. orbata* (Osten Sacken). a. ninth sternum and harpagones, ventral; b. male genitalia, dorsal; c. accessory structures above aedeagus.

FIG. 213. *proxima* (McAtee). a. ninth sternum and harpagones; b. ninth tergum of male; c. harpago, lateral.

FIG. 214. *P. serotina* (Loew). a. ninth sternum and harpagones; b. ninth tergum of male.

FIG. 215. *P. spinipes* (Say). a. front tibia of male; b. ninth sternum and harpagones.

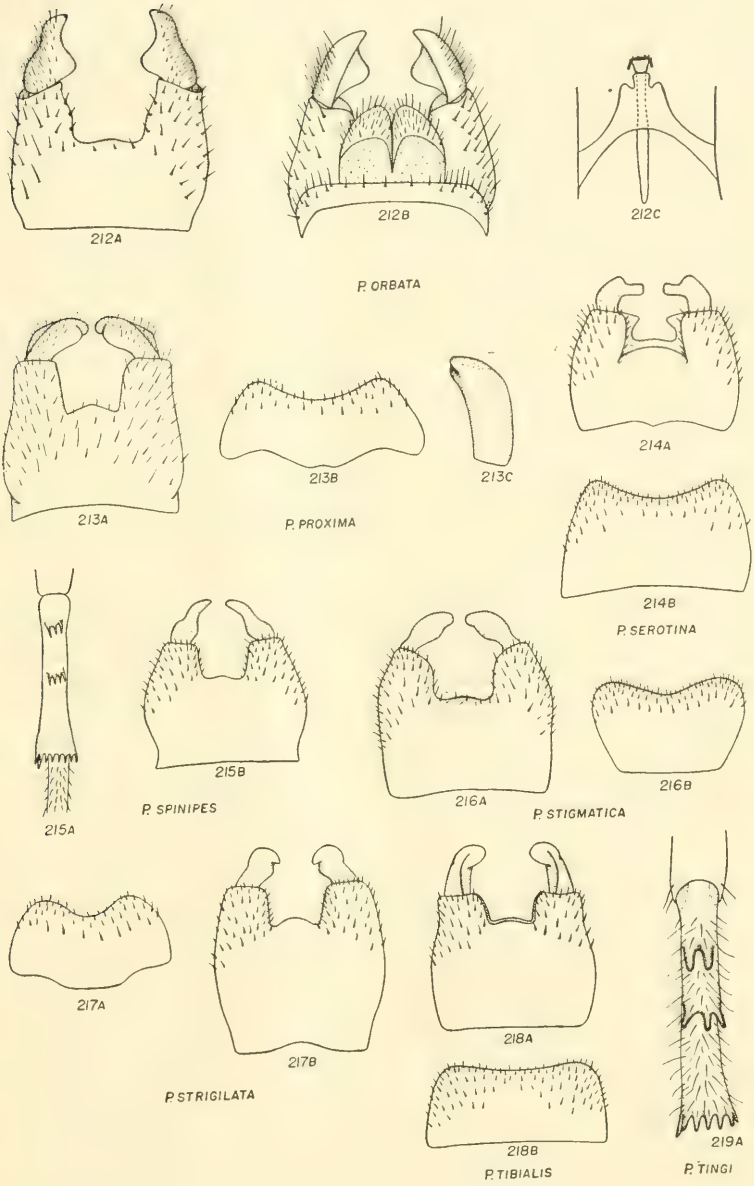
FIG. 216. *P. stigmatica* (Say). a. ninth sternum and harpagones; b. ninth tergum of male.

FIG. 217. *P. strigilata* (McAtee). a. ninth tergum of male; b. ninth sternum and harpagones.

FIG. 218. *P. tibialis* (Loew). a. ninth sternum and harpagones; b. ninth tergum of male.

FIG. 219. *P. tingi* n. sp. a. anterior tibia of male.

PLATE XLI


212A
212B
212C
P. ORBATA
213A
213B
213C
P. PROXIMA
214A
214B
P. SEROTINA
215A
215B
P. SPINIPES
216A
216B
P. STIGMATICA
217A
217B
P. STRIGILATA
218A
218B
P. TIBIALIS
219A
P. TINGI

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXX, pt. II.] JUNE 15, 1945 [No. 16

The Occurrence of *Eucastor* and *Epigaulus* in the Lower Pliocene of Trego County, Kansas

By CLAUDE W. HIBBARD, University of Kansas, and LESTER F. PHILLIS, Canton, Kan.

ABSTRACT: A lower Pliocene deposit is reported from Trego county, Kansas. There have been collected from this deposit the remains of *Eucastor* cf. *tortus* Leidy, *Epigaulus minor* sp. nov. and teeth of a small horse (*Nannippus*).

INTRODUCTION

VERY little is known about the occurrence of Lower Pliocene rodents in northwestern Kansas. New locality records of these rodents aid in giving a better picture of their past geographical distribution and contribute to our knowledge of the associated vertebrates.

Lester F. Phillis collected a right ramus of *Eucastor* in Trego county, Kansas, December 21, 1941. Associated with the beaver jaw were the teeth of a horse and a fragmentary catfish spine. In August, 1943, John C. Frye and Claude W. Hibbard visited the locality in Trego county where Phillis collected the specimen of *Eucastor*. They collected a skull, lower jaws and other skeletal elements of an *Epigaulus*, a nearly complete catfish spine, and fragmentary horse teeth.

The tertiary deposit at this locality is a thin veneer on the underlying Cretaceous beds. It is a stream deposit channeled into the Cretaceous, and thins laterally into what appears to be the edge of the old flood plain. It was from the thin flood plain deposit that the *Epigaulus* was collected.

Section measured where secs. 15, 16, 21 and 22, T. 11 S., R. 22 W., *corner Trego county, Kansas.*

5. Top soil.

Pliocene. Feet

4. Fine sand cemented with caliche, gray pink (*Epigaulus*) 3.6
3. Medium sand with some lenses and thin beds of clay (Catfish spine and horse teeth) 10.5
2. Massive silty sand 2.3

1. Clay, tan to gray, with some sand grains (2.9 feet from base is 0.7 foot of thin bedded, lamminated, impure, volcanic ash, interlamminated with silt and clay) 5.0

Cretaceous.

We are grateful to Doctor Edwin H. Colbert of The American Museum of Natural History for permission to study specimens in the museum collection.

Following is a description of the specimens collected at this locality.

Eucastor cf. *tortus* Leidy

Figure 1

A right lower jaw, KUMVP No. 6885, was collected by Lester F. Phillis, December 21, 1941, from the northwest corner of sec. 22, T. 11 S., R. 22 W., Trego county, Kansas, which is referred to the above form. The specimen has been donated to the Kansas University Museum of Vertebrate Paleontology by Lester F. Phillis. It differs from the American Museum of Natural History specimen No. 10822, figured by Stirton (1935, p. 429, figs. 93, 94) in that it is slightly larger; M_3 is not as reduced and the teeth show a greater amount of wear. P_4 possesses a well-developed hypostriid. A shallow mesostriid is present, but it will soon disappear with wear; the metafossettiid is absent. M_1 with greater transverse diameter than M_2, both teeth possess a hypostriid which extends below the alveolar border. Internal striids absent. M_3 is missing, though the alveolus does not look reduced enough for the M_3 of *E. tortus*. It appears to have possessed an M_3 as large as the M_3 of *Eucastor planus* Stirton. The pit between M_3 and the coronoid process is not as well-developed as the pit in *E. planus*. Alveolar length of P_4-M_3 is 17.0 mm. The anteroposterior diameter of P_4 is 6.4 mm.; the greatest transverse diameter is 4.6 mm. The anteroposterior diameter of M_1 is 3.6 mm.; its greatest transverse diameter is 4.6 mm. The anteroposterior diameter of M_2 is 3.5 mm.; its greatest transverse diameter is 4.2 mm. The anteroposterior diameter of the alveolus of M_3 is 3.4, its greatest transverse diameter is 3.4 mm. The depth of the jaw below M_3 is 11.0 mm. The length of the diastema is 15.5 mm. The width of the lower incisor is 4.3 mm.

Another occurrence of *Eucastor tortus* Leidy was reported by Hibbard (1942, p. 248) from Phillips county, Kansas. The specimen consisted of the fragmentary maxillaries with LP^4-M^2 and RM^1-M^3, F: AM No. 24622 from the Childs Frick collection.

Epigaulus minor sp. nov.

Figure 2a-h

Holotype. No. 6886, Kansas University Museum of Vertebrate Paleontology; skull, associated lower jaws and other skeletal elements of an adult individual. Collected by John C. Frye and Claude W. Hibbard, August, 1943.

Horizon and type locality. Lower Pliocene, Locality No. 29, Trego county, Kansas.

Diagnosis. Smaller than *Epigaulus hatcheri* Gidley. Upper and lower premolars and molars with cement forming part of occlusal surface.

Description of Type. The specimen is that of an old adult. The base of the skull is shattered; neither of the lower jaws is complete. Other associated bones are parts of vertebrae, rib fragments, a few toe bones and claws, right scapula, right humerus, right ulna, right radius, left femur and a fibula.

The horns are not as high or as heavily developed as in *Epigaulus hatcheri,* though located posteriorly on the nasals with their posterior borders on a line with the anterior borders of the orbits. The nasals extend past the mid-line between the anterior border of the orbits and the postorbital processes. The postorbital processes are weakly developed. The sutures between the frontals and parietals are unidentifiable and it appears that these bones are fused. The skull is not as saddle-shaped as in *E. hatcheri* and the supraoccipital region is not as high.

There is a variation in the shape of the upper premolars. The right P^4 is more worn than the left and has six enamel lakes. The long internal lake is greatly reduced. There is a well-developed angle on the anterior lingual side of the tooth. This angle is not present on the left, which is oval in outline. The left P^4 possesses six enamel lakes. There are four enamel lakes present on M^2 and one on M^3. There is a well-developed band of cement around P^4, M^2, and M^3. The band of cement is as wide or wider than the enamel band of these teeth. The cement becomes thinner where P^4 and M^2 are in contact. The shortest distance across the palate between the upper premolars is 4.9 mm. The distance across the palate between the last upper molars is 7.45 mm. The transverse width of the upper incisor across its anterior face is 4.15 mm. There is an indication of a slight groove on the outer and medial surface of the incisor.

The left lower jaw is nearly complete though M_2 and M_3 are lacking. P_4 has eight enamel lakes. The transverse width of the lower

incisor across its anterior face is 4.0 mm. The incisor and angle are lacking on the right jaw. The right P_4 possesses seven enamel lakes. The difference in the number of lakes is due to the fact that the third lingual enamel lake from the posterior border in the left P_4 has worn down and divided into two small enamel lakes. Right M_2 is greatly worn and possesses only a small enamel lake on the labial side of the tooth. M_3 possesses a well-developed crescentic enamel lake. There is a well-developed band of cement around P_4, M_2, and M_3 except where the teeth contact each other. The band of cement is as wide as the enamel or wider and is a part of the occlusal surface of the teeth. The coronoid process is broken in both jaws but it extended well above the condyle. The incisor is still present at the level of the condyle. The mental foramen is small. The dental foramen is 2.5 mm., posterior to M_3, and it is in line with the labial border of M_3.

The specimen of *Epigaulus minor* has been carefully compared with Cope's type of the genus *Mylagaulus*. Mrs. Rachel Husband Nichols of The American Museum of Natural History has kindly furnished the following data concerning the type of *Mylagaulus sesquipedalis* Cope, from R. S. Hill's 1877 field book. "The field book is headed 'Tertiary Collections in the Loup Fork Formation in Northwestern Kansas on Sappa and Beaver Creeks.' The type, AM No. 8329, was collected by R. S. Hill in 1877 on Sappa creek, Decatur county, Kansas." We do not know whether the deposit in Decatur county from which *Mylagaulus sesquipedalis* Cope was collected is the same age as the Trego county deposit or whether it is older or younger. The type appears to be a LP^4. It is from a young adult animal. It has not worn down to its maximum anteroposterior diameter, nor is the enamel pattern fully developed.

The occlusal surface of the type has an anteroposterior diameter of 7.9 mm. The greatest anteroposterior diameter of the tooth is 9.9 mm. The transverse diameter of the occlusal surface is 5.4 mm. The tooth has a length of 12.3 mm. The tooth when worn down would be approximately the size of that tooth in *Epigaulus minor*. Whether the pattern would be the same is unknown. At present there is no basis for assigning *Epigaulus minor* to *Mylagaulus sesquipedalis* Cope, except on the basis of size. The same condition exists for the type of *Mylagaulus monodon* Cope, taken from a deposit along Driftwood creek in Hitchcock county, Nebraska. It is only slightly smaller than *Epigaulus minor;* this comparison is based on P_4. The following measurements were taken from the LP_4 of

Cope's type of *Mylagaulus monodon,* AM No. 8327. The enamel on the border of the tooth is broken, therefore the approximate anteroposterior diameter of the occlusal surface is 9.7 mm. The greatest anteroposterior diameter of the tooth is 10.5 mm. All three of these forms could belong to the same species. Sufficient material is not available to show both age and individual variation of the species under question.

Measurements of the type of *Epigaulus minor* nov. sp. and the type of *E. hatcheri* Gidley in Millimeters

	Epigaulus minor KUMVP No. 6886	*E hatcheri** USNM No. 5485
Greatest width of skull across zygomatic arches,	60.5	64.0
Width of skull at occiput	65.0	75.0
Height of horn core above premaxillary	9.25	——
Anteroposterior diameter of horn core at base	12.9	17.0
Conjoined width of horn cores	16.0	28.0
Width across postorbital process of frontals	21.2	27.0
Depth of zygomatic arch beneath orbit	9.45	10.0
Length of diastema between I and P^4	17.0	23.0
Length of P^4-M^3	14.9	20.0
Antoposterior diameter of P^4	9.1	13.0
Greatest transverse width of P^4	7.5	8.0
Anteroposterior diameter of M^2	3.2	——
Greatest transverse width of M^2	4.3	——
Anteroposterior diameter of M^3	1.9	——
Greatest transverse width of M^3	2.9	——
Over-all length of lower jaw	49.2	62.0
Lingual depth of lower jaw between molars	13.0	19.0
Length of P_4-M_3	15.5	20.0
Length of diastema between I and P_4	10.0	——
Anteroposterior diameter of P_4	11.5	15.0
Greatest transverse width P_4	5.65	7.0
Anteroposterior diameter of M_2	2.7	——
Greatest transverse width of M_2	4.2	——
Anteroposterior diameter of M_3	2.45	——
Greatest transverse width of M_3	2.75	——
Over-all length of scapula	61.95	——
Over-all length of humerus	60.8	——
Over-all length of ulna	70.2	——
Over-all length of radius	42.2	——
Over-all length of femur	58.2	——
Over-all length of fibula	46.25	——

* After Gidley.

Nannippus sp.

Figure 3

Fragments of numerous horse teeth were found associated with the beaver jaw. Figure 3, KUMVP No. 6889, is the most complete upper molar taken from this deposit. It was collected by Lester F. Phillis. A fragmentary piece of a small camel jaw was found with the horse teeth.

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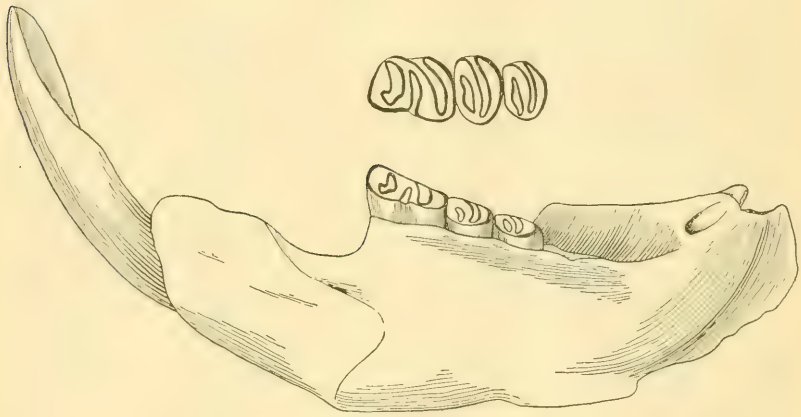

FIG. 1. *Eucastor* cf. *tortus* Leidy, right lower jaw, P_4-M_2, KUMVP No. 6885. $\times$ 1. Drawing by Mrs. Frances Horseman.

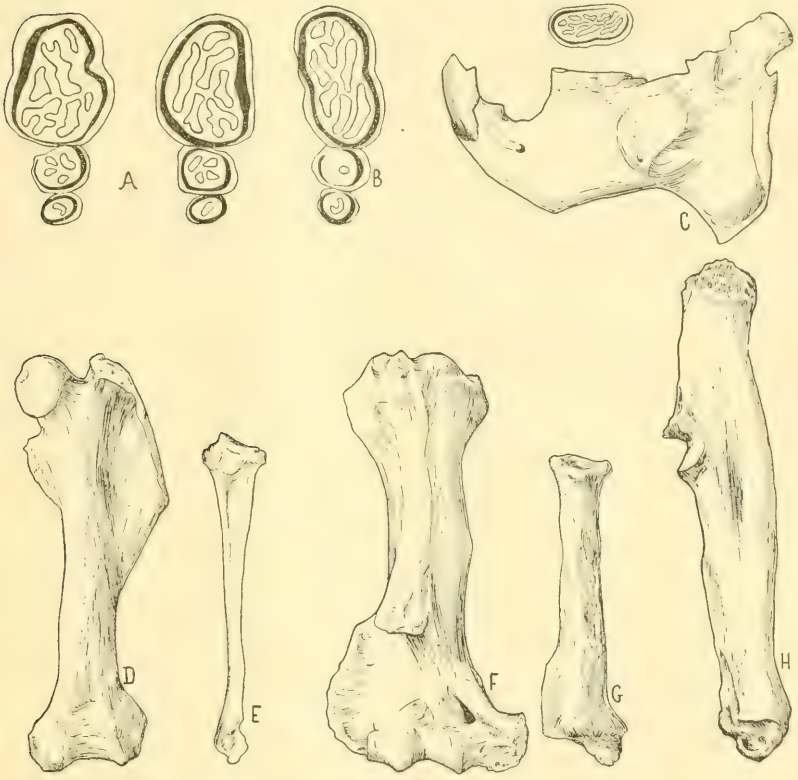

FIG. 2. Holotype of *Epigaulus minor* sp. nov., KUMVP No. 6886, (A) Occlusal view of RP^4, M^2, M^3 and LP^4, M^2, M^3. $\times 2$. (B) Occlusal view of RP_4, M_2, M_3. $\times 2$. (C) Left ramus with P_4. $\times 1$. (D) Left femur. $\times 1$. (E) Fibula. $\times 1$. (F) Right humerus. $\times 1$. (G) Right radius. $\times 1$. (H) Right ulna. $\times 1$. Drawings by Miss Mary Frances Neidig.

FIG. 3. *Nannippus* sp., upper molar, KUMVP No. 6889. $\times 1$. Drawing by Miss Mary Frances Neidig.

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